Metals and Alloys

THE ENGINEERING MAGAZINE OF THE METAL INDUSTRIES

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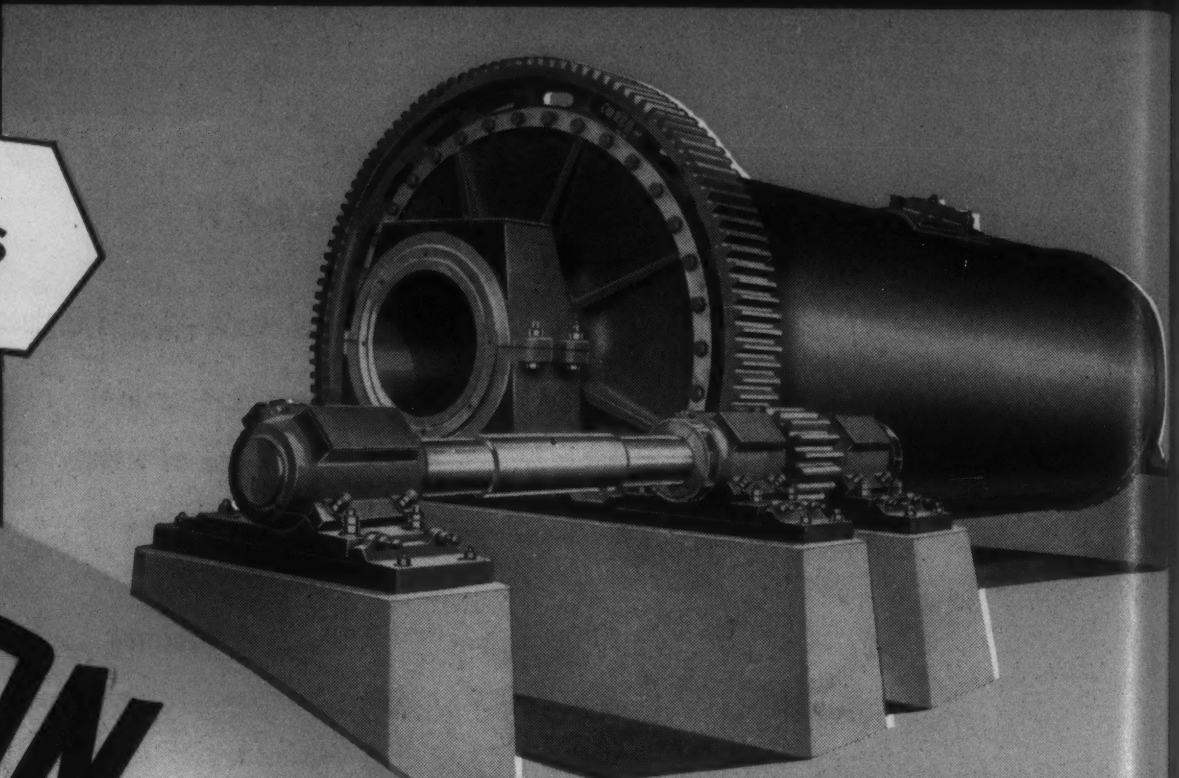

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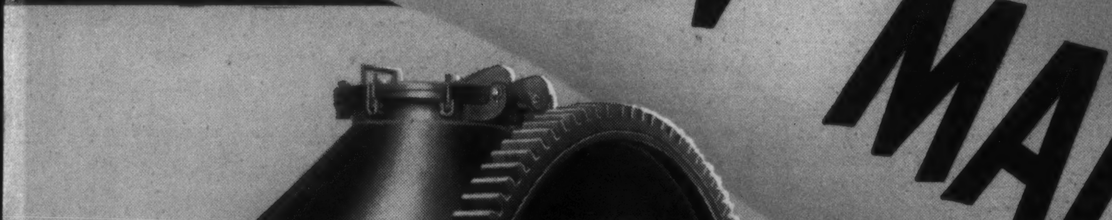

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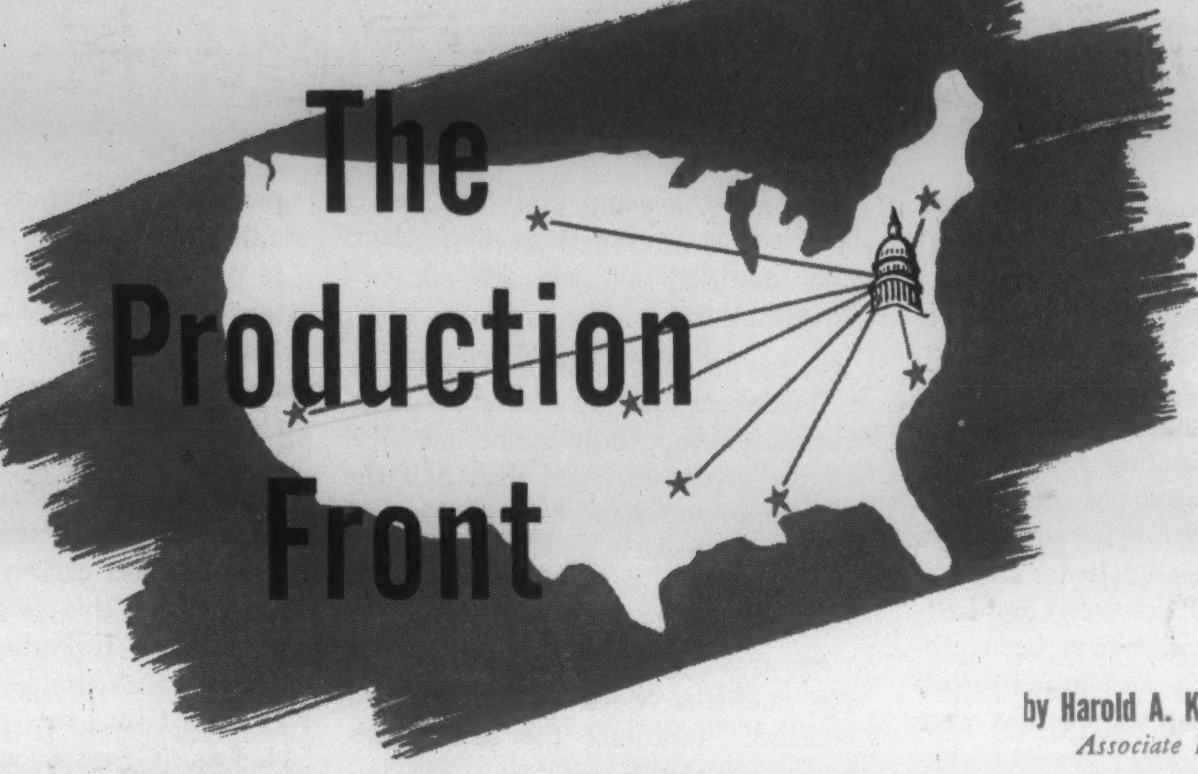
The Production Front



by Harold A. Knight
Associate Editor

Egyptians and beavers often produced for no purpose. . . . It is time to judge quality of our quantity. . . . Flying Fortresses will become a legend. . . . Our tanks and guns licked Rommel. . . . Our "ten silver months" proved sterling. . . . War workers increase in year from 7,000,000 to 17,500,000. . . . Axis has serious limitations of metal supply. . . . Cumulative deterioration will bog down the German war machine. . . . Our 90,000,000 tons of steel yearly enough, says Girdler.

Tin cans as rich in tin as mines. . . . Will calcium be another magnesium? . . . Will steel cartridge cases rust in the jungle? . . . Diecastings join "the 400"! . . . You're good if you can follow the C. M. P. flow. . . . Strangely, perhaps, WPB Steel Div. is composed of steel men. . . . How do you like our cartoon of Tojo and poem? . . . Wood in truck bodies. . . . That idea, metals a mere substitute for wood, made us sarcastic. . . . Say it ain't so, Joe!"

Public's scrap 65 per cent galvanized. . . . We must arm 70,000,000 Chinese. . . . Metallurgists and engineers are not "workers" — oh yeah! . . . WPB predicts 3,000,000 tons of copper available in 1943. . . . Steel capacity to be 99,000,000 tons in mid-1943. . . . Aluminum supply to be 1,500,000 tons yearly. . . . We will turn out 100,000 tons of tin yearly.

Strategy and Tactics

Building of the Pyramids was doubtless as great a production effort, considering the times and prevailing tools, as our own war effort today. But such effort, as far as we can see, had no utilitarian results. The busy beaver frequently cuts down saplings for the sheer joy of production, leaving his work to rot where it falls.

Thus, mere quantity production, *per se,* is not truly assigned value until its results in actual use are probed. Here in the first month of a new year it is appropriate to review some results of our production. We have boasted too long of quantity without, perhaps, appraising value. And value may best be measured by accomplishment in action.

Our Flying Fortresses have proven to be so superb as to become a legend in future years. Those enemy pilots who survived encounters with them will be telling their grandchildren how they appeared in the skys like invulnerable dragons. Both U. S. and British fliers are convinced that our P-51, with the Merlin engine (Mustang) will prove the world's best 1943 fighter plane.

"Gets There Fastest With Mostest"

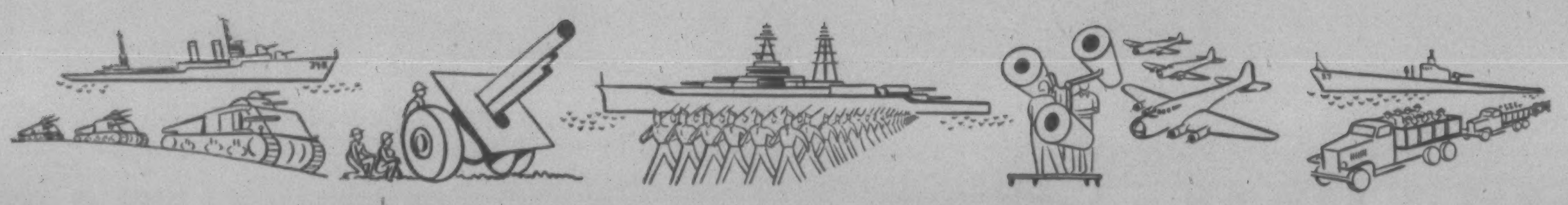
Many military experts are now attributing Rommel's defeat and retreat at and from El Alamein to a new self-propelling American 105-mm. howitzer mounted on a M-7 motor carriage. At first, Rommel could not believe his first impressions of this gun. After his first defeat, he came back for more, whereafter he decided his first impressions were correct, then started on his long retreat.

As regards American tanks, Brigadier-General G. M. Barnes, Ordnance Technical Div. Chief, commented: "The M-3 medium, our principal tank now in action in Libya and Russia, is a wonderful fighting machine." M-4's (1942 medium) are performing in "tremendous style" in the Egyptian campaign, according to Col. Benson, British military attaché in Washington, who was quoted as saying that the General Sherman (M-4) "may turn the tide for the United Nations." In Tunisia, American tanks were usually worsting the big German "Marks" at the ratio of 10 Germans to 4 American tanks destroyed. So much for quality.

Those "Ten Silver Months"

"The year 1942 is the critical year. We have ten silver months in which to hold the enemy," stated Donald M. Nelson last February, when speaking on the gravity of the matériel situation. Luckily for us, the clouds at that time proved to have had silver linings.

Quantitatively, we have produced in 1942, according to an estimate in early December, 49,000 planes, 32,000 tanks and self-propelled artillery, 17,000



anti-aircraft guns larger than 20-mm. and 8,200,000 tons of merchant shipping.

While we have reached the goal in merchant shipping (and that is, perhaps, most important of all) we have fallen behind in other categories. Yet, there are compensating factors. An increasing proportion of our planes are heavy bombers. In addition to tanks and self-propelled artillery, many thousands of scout cars and half- and full-track carriers have been produced to round out mechanized forces.

A year ago 7,000,000 persons were employed in war work; now, 17,500,000. In 1943 we must add 5,000,000 to our working and fighting forces. Last year food production was 12 per cent above 1941 and 40 per cent over the war year of 1918. Military and lend-lease buying will soon take 25 per cent of our farm output.

3,000,000 Tons of Copper in 1943

Here, near the start of a new year, few, if any, problems appear insurmountable. Among materials, rubber seems most serious. Even in copper, the situation looks better than a few months ago, with 3,000,000 tons in sight for 1943 consumption, according to WPB. Compared with our enemies, our raw materials are truly abundant. Wise men say that German and Japanese airplanes have by now reached or even passed their peaks of efficiency, with inferior materials to enter their construction hereafter.

Though Japan has captured temporarily a wealth of raw materials, it will be impossible for her to exploit them to any appreciable extent while conducting a war on several fronts, especially as long as it takes much equipment and technical skill, which she cannot now spare, to develop them.

"How much longer the war will last may hinge directly on the extent to which the Axis can operate its estimated capacity of 53,800,000 tons of steel annually in the face of intensified bomb damage to plants and transportation systems," states the American Iron and Steel Institute. Though Germany probably has iron ore and coal enough, many important mines are located so far from steel plants that transportation was difficult even in peacetime.

Axis Has 10 Per Cent of Our Nickel

"Germany has available in Continental Europe only about one-third of the manganese, less than half the chromium and a mere 10 per cent of the nickel needed to keep pace with the United States in producing alloy steels. Even if all Turkish chromite were available to Germany, the supply would be less than the estimated demand," continues the Steel Institute.

"None of the countries of Continental Europe, including those parts of Russia that lie behind the German lines, is the leading producer of any strategic mineral. Except for Asiatic Turkey, none ranks even as a major producer. Every major artery of supply, moreover, falls within a 1000-mile bombing range of London, Moscow or Alexandria."

The Northern Miner, Toronto, writes much in the same vein. "Germany has, in her own production or that of her subject countries, plenty of iron, aluminum and lead. Mercury is in good supply from Italy, which supplements the German demand for aluminum also. Germany, so far as supplies of basic war metals is concerned, is in a pocket. She cannot get supplies from abroad.

"As to copper, in 1939 productive capacity of Europe was 163,344 short tons, including output of Germany, Finland, France, Norway, Sweden, Yugoslavia, Spain and Portugal. That year German consumption alone was 373,680 tons, imports of refined copper were 89,355 tons, and imports of copper ore, matte, etc. refinable in Germany was 675,000 tons. The spread between consumption and production of Europe is so obvious that it needs no comment."

When Germany Will "Bog Down"

The same magazine, speaking on Germany's nickel, states that the Petsamo mine in Finland is in No Man's Land, hence impractical to work. Figures for German imports even in peacetime were puzzling, only about 6,000 tons a year being accounted for in the statistics. Canada alone, among the United Nations, produces around 170,000 short tons annually. As to manganese, Hungary, Italy, Rumania and Sweden had a production of only 134,604 tons alongside 2,900,000 tons for Russia alone that year. Germany produces no tungsten, which is probably the most eagerly sought metal in the world at this time. Her only possible source is Portugal, which ranks fifth in world sources."

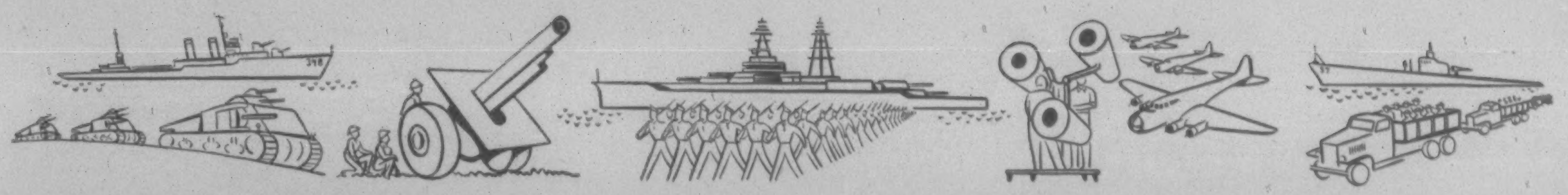
The Canadian publication concludes: "Germany will spin out the last pound of metal until the day when a cumulative deterioration lets her war machine bog down."

And, while we still speak of supplies, one of our most controversial topics continues—as to whether our steel supply is sufficient. This is a question that has been raging for two years and seems as much unsettled as when Walter S. Tower, president of the American Iron and Steel Institute, in the fall of 1940 estimated that 8,000,000 to 10,000,000 yearly would be enough for defense (not war, of course). Yet, in recent weeks an easing situation in tightness of supply has been noted in pig iron, steel and machine tools, despite Government protests to the contrary.

90,000,000 Tons Should Suffice

Blunt-speaking Tom Girdler told the New York Chamber of Commerce not so long ago: "No one can convince me that there is any real shortage of steel in this country; not with an annual steelmaking capacity of 90,000,000 tons. I think millions of tons are lying around in various plants waiting to be used. Some of the idle inventories are necessary, but a lot of that steel ought to be at work." Anyway, United Nations steel output generally exceeds that of the Axis by 50,000,000 tons annually.

An interesting sidelight on our supplies involves our reservoir of tin in the form of the humble can. An alluvial tin deposit in the Far East, which averages 1 per cent tin content,



is very good property. Old tin cans now being scrapped contain over 1 per cent tin, though the percentage will become less in the future, since as little as ½ per cent of tin is now being put on cans. Of course, the detinning process is more costly than the concentrating and smelting of ores, yet in can salvage we get an important by-product, steel.

Calcium to Be Another Magnesium?

New adaptations of old metals constantly come to the fore, and may survive in peace. An interesting possibility is calcium. It is suggested that a few years ago magnesium was regarded as chiefly useful as an ingredient of stomach remedies such as Epsom Salts, magnesium citrate, etc. But look at metallic magnesium now!

Similarly, calcium may emerge as a leading metal. It is already an important element in dolomite, from which magnesium is extracted. Combinations of lead and calcium are finding successful applications, such as in rivets, while the Bell System has in operation today several hundred miles of power cable with lead-calcium sheath, which has as yet shown no important defects. Field tests reveal that this metal has "definite advantages" in the power cable field.

A process called the "cold impregnation" of steel with silver to produce a substitute for tin was recently patented by A. D. Slatkin, Montreal inventor, and sold to Arthur F. Cutten, Toronto business man. The inventor claims that 100 lbs. of steel impregnated with 5 oz. of silver has a much more attractive appearance than tin, is equally ductile and, when lacquered, is equally suitable for tin cans and will neither chip nor peel under pressure.

Yet, one despairs of doing much with silver because of the artificial high prices. Any plain-spoken author who writes the history of this war will undoubtedly devote a chapter to the "ten silver months," of which Donald M. Nelson spoke—but he will add a sarcastic twist. These silver months were devoted to shameful tactics on the part of our silver senators that will long live in ignominy—capped by a filibuster by a silver state senator. Filibusters are a disgrace to the American system of government in peace—they are treason in time of war!

Will Steel Cartridge Cases Rust?

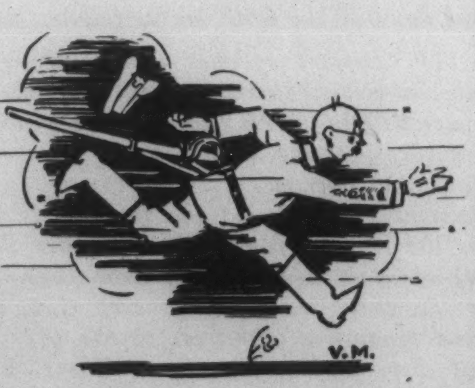
Metallurgical experts are frequently skeptical about some of our alternate metals in actual service. Take our gilded steel cartridge cases. Some claim that rust sets in through pin holes in the coatings, particularly in jungle climates. A United States marine on the firing line on Guadalcanal does not have time to sort through his cartridges to find one showing no traces of rust. The empty rusted cartridge case may be impossible to eject. Can the cartridges be given a coating of grease, do you suppose?

Speaking of cartridges, the necessary stupendous production is easily explained. Take 30-calibre bullets. The potential firepower of 1,200 carbines and 2,000 rifles in an armored division is 100,000 shots a minute. Machine-gun squads can blast away 1,800,000 more. Scout cars, trucks and tanks all firing would run the total up to 3,650,000 bullets in 60 sec.

Tojo Was A Vulture

(Metallurgically Speaking)

by V. M. McConnell



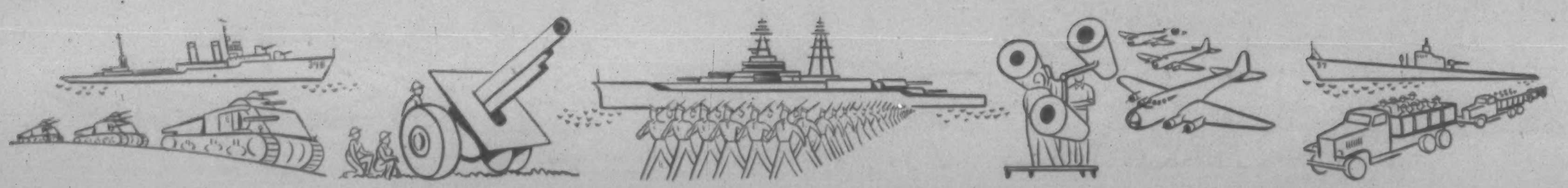
Tojo was a brass hat,
Tojo was a Jap.
Tojo came to our house
And carted off our scrap.
We went to Tojo's house
Tojo wasn't in.
Tojo came to our house
And stole a pile of tin.
We went to Tojo's house.
Tojo up and fled.
We took back the tin he took
And paid him off in lead.

Die Castings Join High Society

It looks as though die casting has become of age and receives recognition as a basic process in a class with rolling, forging and ordinary casting. At first, die casting was used for making articles that underwent but little stress and strain in use, such as automobile hardware. Satisfactory provision has been made for inspection of zinc or aluminum die casting components in bomb and shell fuses through not less than 1,400,000 volt capacity X-ray apparatus, which will insure that not even the smallest flaw or crack inside the casting will escape inspection.

"Some ammunition components can be produced at the rate of 4,000 an hour, and millions of satisfactory die castings have already been turned out," stated Harvey Anderson, chief of the Conservation and Substitution Branch, WPB Conservation Div. "Army and Navy design engineers, realizing the need for speedy ammunition production, will be encouraged to specify die cast parts for many critical uses so long as they can be reasonably sure that such parts will never be responsible for tragic premature explosions or other ammunition failure," stated Mr. Anderson.

Inspection specifications, as laid down by the Die Casting Industry Advisory Committee, call for X-ray examination of the entire run of sample



castings and of a specified number of random samples taken from the production run. Sample castings will also be subjected to break-down tests.

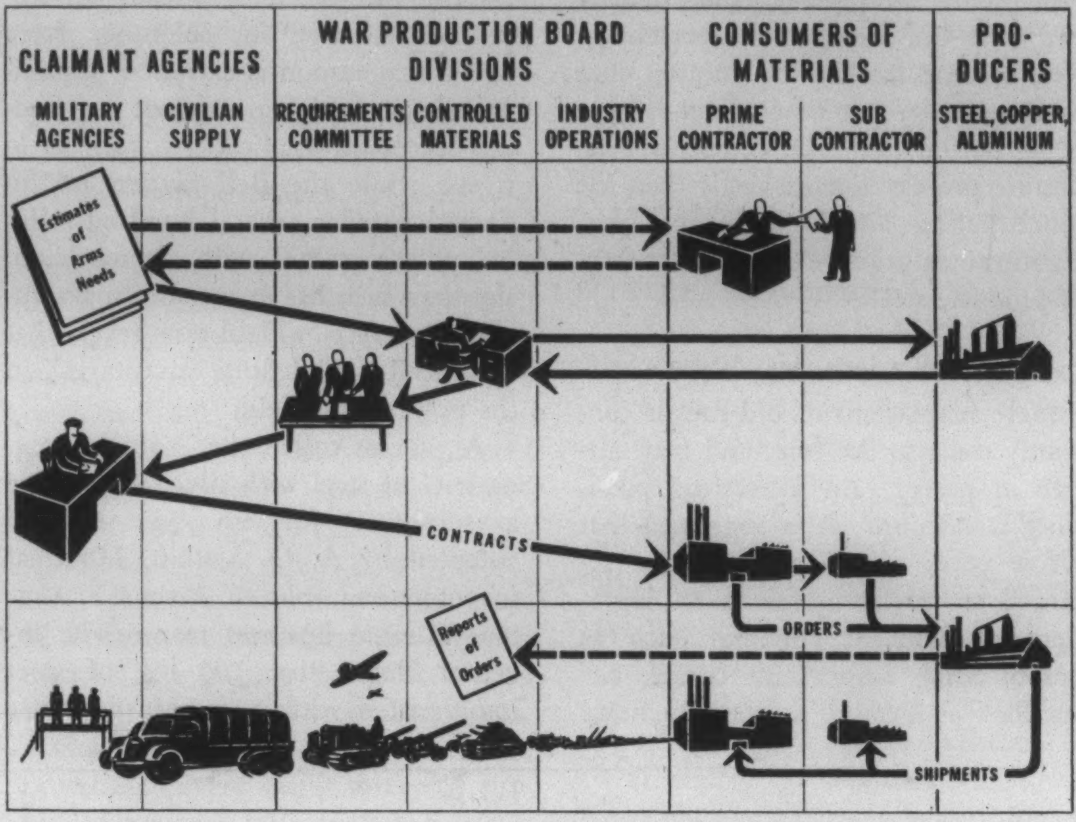
Lead-Coated Equipment for Infantrymen

Apparently pig lead is the one metal which is abundant, both among the United Nations and the Axis. We produce only 8,000 tons per month less than we consume, the rest being supplied easily by Mexico, Canada and Australia. Returning transport ships from Australia presumably bring back much metal, stopping enroute at ports in South America. Metals Reserve Corp. is stocking much lead.

Army Ordnance is adopting lead to many uses that are decidedly new. Successful experiments have been carried on with coating with lead much of the equipment which the infantryman carries. At first blush it would seem impractical because of its weight. Actually, the equipment has proved lighter than that coated with zinc, since thinner coatings are needed.

After all, lead is a proven coating material. Paint, the time-honored coating, contains large quantities of lead.

The "Flow" Under Controlled Materials Plan



"Here is a flow chart that won't end (nor has it even started) all flow charts," writes Leslie Peat, who keeps "Production Front" informed about behind-the-scenes in Washington via thumb nail word sketches. "I've checked it with a dozen men in Washington, including masterminders of the plan." Mr. Peat contributed the original chart, an affair of lines and arrows, and the captions below. To our kindergarten mind, symbolic pictures seemed desirable and our artist, Gil Miller, put our childish ideas into fruition. The ebbs and flows of the CMP are as follows, as apply to munitions:

(1) Claimant agencies (except Office of Civilian Supply) with the aid of prime and sub-contractors, estimate products required. Claimant agencies then advise (2) Controlled Materials Div., WPB (until further notice, the former Iron and Steel, Copper and Aluminum Branches), giving carbon copies to the (3) Requirements Committee, WPB (chairman, Ferdinand Eberstadt). This committee, or board, is composed of representatives of the claimant agencies, and the function is to adjust demands to estimated supplies available for the ensuing year. The R.C. then divides the materials available between each of the (4) claimant agencies and notifies (5) Controlled Materials Divisions as to how much of the controlled materials each C.A. may expect to receive. C.M. divisions may also issue production directives to the (5a) Producers, directing how much of a given alloy and shape they may produce. The C.A. then makes an allotment by issuing an allotment number to the (6) Prime Contractor, who, in turn, extends this to his several (7) Subcontractors, who place orders for materials with the (8) Materials Producers. These materials orders are reported to the (9) Controlled Materials Divisions by the M.P., who ship materials to the (10) Sub-contractors and (11) Prime Contractors, who fabricate and assemble the product and ship it to the (12) Claimant Agency, thus completing the cycle.

Under the CMP, the manufacturer will continue to depend on preference ratings under the PRP, or allocations, for materials other than those under this control (iron, steel, copper and aluminum). But by July 1 PRP will be "out the window" completely.

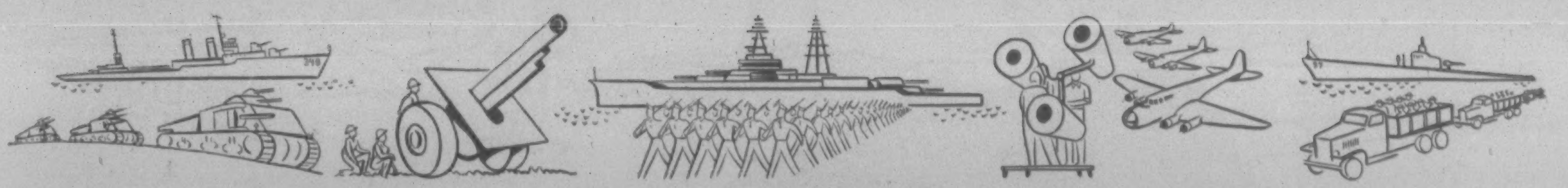
These Men Know Their Billets

For the first time since the organization of the materials control effort during the days of the National Defense Advisory Commission early in 1941, the Steel Division of WPB is in the hands of practical, experienced steel men.

The new organization of the division, set up to better implement the Controlled Materials Plan, elevated genuine metal men to key posts and retained the majority of able metallurgists, an analysis of the new division shows. Under Hiland G. Batcheller, director, four assistant directors have been appointed, each in charge of an experienced executive. They are:

Ferro Alloys: Under Miles K. Smith, chief metallurgist, Latrobe Electric Steel Co. Chief of the Ferro Alloys Branch is Andrew Leith, a veteran OPM and WPB official. He has seven sections.

Raw Materials and Facilities: Frank E. Vigor, American Rolling Mill Co., an authority on transportation. His Plant Facilities Branch is in charge of E. H. Brown, vice president of Allis-Chalmers Co., with four sections. The Metallurgical & Construction Branch is headed by Herbert J. French, president, American Society for Metals, with E. J. Hergenroether, formerly metallurgist for International Nickel Co., and a veteran in the Government's conservation effort, as



assistant chief. This branch has four sections. The Raw Materials Branch is headed by W. C. Kerber, who has five sections.

Production: D. F. Austin, vice president, Carnegie-Illinois Steel Co., and former acting chief of the Iron & Steel Branch, has four branches. Alloy Steel Branch, headed by W. J. Priestley, vice president, Electro Metallurgical Co., has four sections. The Wire & Heavy Products Branch, with five sections, is headed by J. V. Honeycutt, a veteran OPM and WPB executive. The Bar, Sheet & Strip Branch is headed by G. G. Gries, vice president, Great Lakes Steel Co., and has three sections. C. H. Longfield is chief of the Tubular Products & Tinplate Branch, which has three sections.

Program & Distribution: N. W. Foy, general sales manager, Republic Steel Corp., with four branches. The Program Distribution & Control Branch has five sections, four of which are headed by experienced WPB executives. Export Steel Branch is in charge of P. F. Schucher, with four branches, each under an export authority with wide experience in this phase of industry. Steel Recovery Branch is headed by C. V. Bradley, president, W. J. Holliday Co., and is in charge of sales, distribution and allocations. It is located in Pittsburgh. The Warehouse Steel Branch is in charge of J. R. Stuart, who has been heading this activity in the former Iron & Steel Branch. He has three branches.

Mr. Batcheller has a strong industry advisory committee, and several specialized advisory committees composed of important men in the steel and alloy industry.

"Charlie McCarthys" for Truck Bodies

It's an ill wind, etc.—as far as thousands of small woodworking plants are concerned in the Ordnance Department's Army truck program. Many of these companies faced extinction for the duration until the Tank-Automotive Center decided that the Army would have to get along with wooden bodies to save steel.

To date, 73 body builders throughout the country have contracted with nearly 3,000 woodworking companies to furnish bodies and body parts built to standard specifications. Chasses are shipped to body builders near ports of embarkation, where the bodies are installed and the vehicles are prepared for shipment overseas. Contracting is done by the thirteen Army Ordnance Districts.

"The Master Race"

Those dictionaries and books on sociology we read around 10 B. H. (Before Hitler) were all wrong. They described a "master race" as supremely intelligent. But the German master race isn't that, else it would not have expected to get away with degrading mankind generally.

They said a master race was superior in physique and morale. Yet Hitler's master race runs from the bayonets of the Russians and the "Aussies." They described a m.r. as superior in inventive genius. But American Flying Fortresses, tanks, bombsights, etc. are the superior ones.

Also, that a master race, secure in its superiority, was tolerant, even generous towards others. But Hitler's tribe kills Jews in cold blood, robs Norwegians who sheltered their children during the first World War.

That a master race writes literature and music, paints pictures and carves statues that live forever. Yet Hitler's real-McCoy not only fails to create, but destroys what exists.

That even a master race recognizes a deity. But the God of the real master race is merely one of them — Hitler himself.

So, we better throw those dictionaries and sociology books away — perhaps "right in der Fuehrer's face"!

We Take a Sock at Dyke!

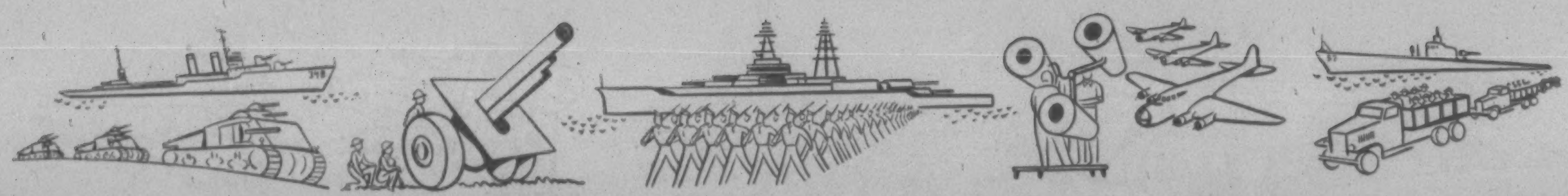
Last month we told how one Nathaniel Dyke, Jr. was predicting that soon metals would be merely a substitute for wood. Remember? He had something, too. Said that nature was constantly replenishing the supply and that by-products such as sugar or alcohol would be obtained in the future. Catlike, we arched our back, but said nothing intelligible in defense of metals.

Since then it came over us to say something in behalf of metals—not that metals need defending. But who ever heard of campaigns to collect scrap wood? Nature does not need to replenish metals—they are everlasting. The gold which adorned the back-scratcher of Confucius is now in the form of a ring on Hitler's hand. The bronze which formed the rocker on the cradle of Moses is now a candlestick in a Pennsylvania coal miner's home (and will be turned in on the next civilian scrap drive for copper now being formulated at Washington). So take that, Dyke!

"Say It Ain't So, Joe"

A baseball idol threw away a critical baseball game for filthy money some 15 years ago. When the scandal was spread over the front pages of hundreds of newspapers, thousands of back-lot baseball players felt that the bottom had dropped out of the universe. Freckled and red-headed urchins hovered around the fallen idol during his few public appearances and implored him with quavering voices: "Say it ain't so, Joe!"

It is with much the same feeling that we, who have spent most of our business life with the metal fraternity, read the charge that a leading maker of wire and cable had deliberately sent inferior and dangerous products to our own soldiers and those of our Allies. We had somehow felt that the metal men were a superior people. Perhaps the metal with which they worked imparted stamina to their characters. Many of the metal men today are the great grandsons of our old ironmasters, a rugged and two-



fisted lot, honest and quick-on-the-trigger in the presence of evil.

Funny, too! Just two days before, our conversation at the luncheon table revolved around the theme that there had so far been no scandals in connection with this war. During the Revolutionary War there had been much confusion, mob-rule and irregular practices, excused in later years because of the pioneer nature of our country. In the Civil War draftees could hire substitutes. In the Spanish-American War the spoiled and poisoned beef fed the soldiers still lives in infamy. In the first World War was the profiteering.

So we thought the slate was clean this time. True, an Ohio war manufacturer was paying stenographers $30,000 a year and giving employees periodic vacations in Florida. Yet, this was apparently not injuring our fighting men.

As we write this, the wire-cable "scandal" has just broken in the papers. We itch to beg: "Say it ain't so, Joe." We still hope that "Joe" can truthfully say, "No." Such alleged infamous deeds hurt not only our soldiers and the wrongdoers, but you and me—130,000,000 of us.

Public's Scrap 65 Per Cent Galvanized

The man in any factory who designates what "dormant scrap" is should be a top executive, one who can make decisions with authority and is not afraid of someone over him. That is the gist of what William L. Batt, vice-chairman of WPB, told us. A lesser executive is always fearful that he will condemn to the scrap pile some high-priced equipment which the boss will still call serviceable.

Macaroni makers made a novel contribution to the dormant scrap campaign. They cut down sizes of macaroni, spaghetti and egg noodles by 26 sizes and shapes, thereby releasing many metal dies for scrap.

One of the most wasteful lines is tool steel, where only 20 per cent was originally recovered in form of scrap. WPB soon expects to have 50 per cent recovered—that will probably have been accomplished as this is read.

One pregnant idea brought out at a conference on industrial salvage is that some of the Army-Navy "E"s should be awarded to good industrial salvagers. Probably salvage is more important just now than production.

As to the hue and cry to the effect that the great American public was needled into giving their scrap all, only to have the steel mills high hat it, one Washington authority reminded: "Look at the aluminum scrap. Remember when the public became skeptical? Well, all that aluminum has by now been used up."

And, speaking again of the public's scrap, we asked a leading scrap expert at Washington which district of the country produced the best public scrap. We suspected that New York's scrap was mostly vanity cases, tin horns used on New Year's Eve and other fluff stuff, whereas country districts would yield plows, pickaxes and other heavy stuff.

The expert would not answer this question, but came through with the fact that 65 per cent of the Nation's public scrap is galvanized, 11 to 15 per cent cast iron, 5 per cent nonferrous metals, and the remainder unclassified.

We Must Arm 70,000,000 Chinese!

Take an aspirin and let's consider what we still have to do on the production front. We heard a lecture by Dr. Bangnee A. Liu, author, educator, lecturer, traveler. "We have in China today 5,000,000 fighting men," he said in best Oxford English. "We have another 15,000,000 men in training camps. And—"(and here he watched the audience intently to see what effect his forthcoming statement would have) "we have 50,000,000 more men of military age and proper physical qualifications.

"When the U-ni-ted States manufactures and transports into the hands of these 70,000,000 men the necessary guns, tanks and ammunition," he spoke somewhat roguishly and skeptically, "China indeed will have a strong fighting force."

Metallurgists and Engineers Not "Workers"

Metallurgists and engineers with management responsibilities are not classed as "workers" in the sweeping War Manpower "labor freezing" program of the "Detroit Plan," Montague Clark, district director of WMC, told METALS AND ALLOYS.

However, if such engineers and technologists feel that they can contribute more to the war effort by making a change of employment, they may apply through the United States Employment Service.

The labor-freeze program will be applied only in areas where there is a serious shortage of skills, WMC Director Paul V. McNutt explained. The plan was first tried in Louisville several months ago to protect war plants there from suffering pirating of skilled workers from other cities.

Metal Outlook for 1943

The following metal supply outlook for 1943 has been estimated by WPB thus:

Steel—Capacity, 99,000,000 tons by mid-1943; output for year, 90,000,000 tons.

Steel alloys—Production, 3 times 1942 and 6 times 1940.

Copper—3,000,000 tons available.

Aluminum—Supply available 1,500,000 tons yearly.

Magnesium—Production of 300,000 tons against 24,000 tons yearly month before Pearl Harbor.

Tin—Primary production 100,000 tons.

Lead—Most plentiful of major metals.

Chromium — Output of 750,000 tons.

Molybdenum—By mid-1942 U. S. produced 85 per cent of world's supply. By Dec. 31 another 15 per cent was added to tonnage.

Nickel—Canadian production, already 80 per cent of world's total, will increase considerably in 1943. Cuba and New Caledonia will step up output.

Manganese—Present stockpiles are very large and domestic production is being stimulated.

highlights
OF THIS ISSUE . . .

Annual Engineering Review

Ten Silver Months

The theme of this year's Annual Engineering Review Issue is Donald Nelson's *Ten Silver Months* (page 48)—the challenge of 1942 as "the critical year" in this country's history. The review articles themselves sharply record the manner in which America's engineers and production men met the crisis with an on-to-victory surge.

Production of Metals

The broad field of metal-production is reviewed in articles on blast furnace practice, on open hearth steel, on electric furnace steels, on copper and brass, on the white metals—lead, tin, zinc, etc.—and on aluminum and magnesium.

Foundry Practice

Signalizing the emergence of engineering as a dominant factor in foundry operations, a special section (page 59) is devoted completely to engineering-review articles on foundry practice. Gray iron, steel castings, malleable, aluminum and magnesium castings, and brass and bronze castings are represented with individual articles by an assortment of experts.

Metal-Working and Treating

Seventeen articles comprise the third editorial section, starting on page 67, on the fabricating and processing operations. Engineering authorities discuss various aspects of machining, forging and forming, heat treatment, welding, cutting, soldering and brazing, cleaning and finishing, die casting, powder metallurgy and industrial salvage.

Materials and Design

Engineering trends in the applications of materials—metals and non-metals alike—are plentifully recorded in 6 articles, beginning on page 91. Ordnance design problems, use of the NE steels, the present and future competition among materials, applications of the rival metal-forms, and the heavily increasing use of non-metals in the metal industries are reviewed. A 14-page tabulation of new materials and finishes of 1942 (page 101) completes the section.

Testing, Inspection and Control

Appropriately starting with an article on ordnance inspection, the concluding engineering-review section, on technical control of material- and product-quality (page 115) contains in addition articles on mechanical testing, metallography, instrumentation and radiography.

Metallurgical Engineering Digests

Triplexing

The place of the Bessemer converter in war production is nicely brought out in a discussion by Griggs (page 132) of its use in triplexing.

Aluminum Foundry Operations

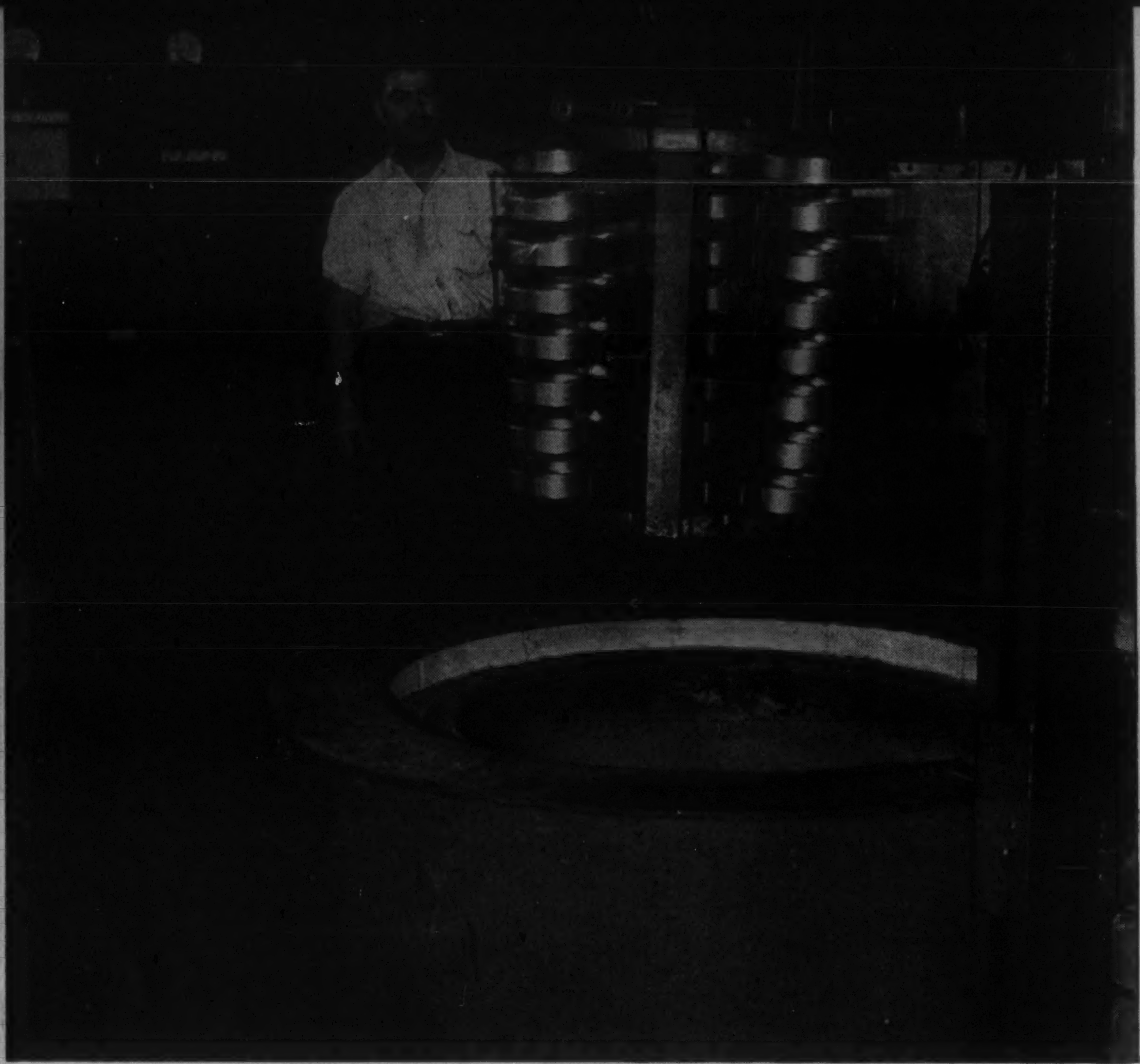
Geschelin (page 144) presents a comprehensive description of engineering practice in the manufacture and finishing of castings at a large "automotive" plant.

Fabricating Tank Armor

An interesting discussion of the pro's and con's of riveting, welded fabrication or a combination of steel castings and welding for tanks and other armored vehicles is given by Woodward (page 150).

High-Temperature Springs

Materials for high-temperature springs are mostly nickel-base alloys, say Betty, McQueen and Rolle (page 190), who outline the service factors and properties of such springs.



Heat-treater lowers a charge of bearing races into furnace, for hardening by the Vapocarb-Hump Method. There will be three advantages: little or no refinishing; practically no rejections; and long life for the races. These result from Vapocarb protective atmosphere; rate-of-heating control; Hump Method detection and recording of the critical for each individual furnace charge; fully automatic Micromax control of the furnace.

REMEMBER THE "HUMP"?

It's Fine For the New Low Alloys!

Shown here are scenes of furnace operation in a heat-treat which is well-equipped to handle the new, so-called "low-alloy" parts.

This heat-treat was originally set up to harden and temper the races for high-alloy anti-friction bearings. Like many another shop, this one selected the Vapocarb-Hump hardening and Homo-Tempering Methods. Now races will be made of low alloys, instead of high . . . but see how well they, also, can be handled:

First, the "Hump Method" applies with redoubled value. For, with alloy content going down and carbon going up, the relation between critical and quench becomes increasingly important . . . and the Hump Method points an unerring finger to the critical—regardless of heating rate, actual temperature, or any other factor. Obviously, the Hump is what the heat-treater needs for the low alloys.

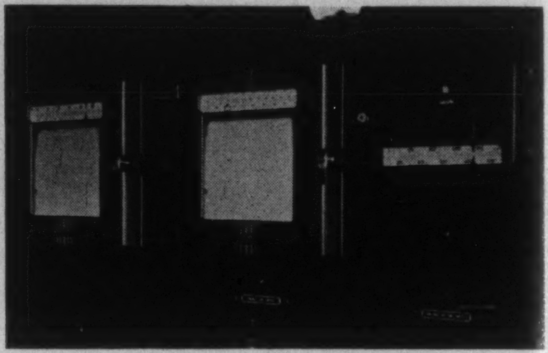
ARMY E NAVY

V depends on me!

Then there's the Vapocarb atmosphere. Designed to protect the surfaces when there were plenty of alloying metals, its value increases as the percentage of alloy shrinks. Vapocarb helps a little alloy go the limit in service.

Warp? The Vapocarb-Hump Method's Micromax Pyrometer applies a very special Rate of Heating Control which can be used to end all unexpected warp. It does this by letting the heat-treater find out, from the work itself, just what the fastest safe heating rate may be; the man then sets the Control, and the work is automatically handled in accord. Warp is beaten before it starts.

If you have a heat-treatment problem for ferrous alloys of any type, let us know. We'll gladly try to help solve it.



If you've used a Micromax Pyrometer, you know it holds any furnace to its best performance. An advantage of Vapocarb-Hump hardening and Homo tempering is that these Methods are designed to take full advantage of the Micromax abilities . . . its micro-responsiveness, its accuracy, its fully-automatic nature. Photo shows control panel for a Vapocarb-Hump and Homo equipment.

Homo Method Tempering gives "perfect" uniformity because forced convection carries clean, electrically-heated air to every exposed surface of each part in the furnace charge. Under automatic Micromax control the work comes swiftly up to temperature; soaks with no overshooting or falling away; leaves the furnace ready to pass any Army or Navy inspection for uniformity.

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LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS . TELEMETERS . AUTOMATIC CONTROLS . HEAT-TREATING FURNACES

editorial

Today in the Metal Industries

Engineering developments in the metal industries last year were not only large in number but also far-reaching in their ultimate effects. Some of them are having and will have a profound influence on the future of these industries—in many cases revolutionary in character. The stupendous war demand for metals, both ferrous and non-ferrous, has been the chief cause.

While the engineering reviews in this issue tell the broad story of many phases of the metal industries, it is our purpose here to emphasize two or three developments of major significance.

Approaching the phenomenal has been and still is our production of steel, both open-hearth and particularly electric. An output of about 87,000,000 net tons of ingots has been the 1942 record. This is an increase of about 12,600,000 tons over the 1941 total.

Many difficulties have been involved in this accomplishment—a growing lack of scrap, a restricted supply of several strategic materials, the necessity of modifying furnace practice in several important particulars, skill in quick repairs, and so on. To accomplish all this is a metallurgical engineering achievement of the first order—one to be justifiably proud of.

The development of the National Emergency steels has placed the alloy steel industry in a radically different position from that occupied before the war. These steels of low or simple alloy composition are taking a place in industry that is significant as to their effect on the future. It is generally expected that we have seen in many cases the last of many of the high or complex alloy steels.

The N. E. steels have some remarkable properties—suspected possible when they were conceived but demonstrated actual as experimentation and trial have proceeded. This also is a highly important metallurgical engineering accomplishment.

The expansion in the production of both aluminum and magnesium has reached proportions not even deemed possible or necessary two or three years ago. The totals in both cases are many times the output in 1939 or 1940.

This expansion has involved the overcoming of many technical difficulties and the solution of several metallurgical engineering problems, particularly in the case of magnesium. That the large capacity for producing these metals will have a profound and far-reaching effect on the future of the whole group of metal industries is receiving careful thought.

Several other developments could be mentioned—new knowledge in the technique of heat treatment; substitutes as metals, as alloys or even as non-metallics for strategic materials, many of them likely to be of a permanent nature; the production of cast and also light armor plate and their heat treatment; the expansion in the copper, lead and zinc indus-

"Without your assistance,
it couldn't have been accomplished"

OFFICIAL U. S. NAVY PHOTOG

Record-breaking service on an important Navy order, made possible by Ryerson co-operation on steel! "Without your assistance, it could not have been accomplished," writes the contractor—and again Ryerson teamwork scores.

Cases like this—in which quick Ryerson steel-service has speeded up war production—run into the thousands! While we have not kept count, enough Ryerson customers are working on war contracts to firmly establish Ryerson steel from stock as a vital part of the war production machine.

Hundreds of plants on war contracts are *depending* on Ryerson for steel. An important order here, too urgent to wait on mill production; a few bars there; some strip or a few sheets somewhere else. It multiplies into tremendous tonnage—all labeled "RUSH"—and it's all going into tanks, planes, guns and ships to beat the Axis!

It is a source of pride to the Ryerson organization that its One Hundredth Year finds it on the direct line of greatest service in the war production program—There is a great deal of satisfaction in a War Production Unit report: "Without your assistance it could not have been accomplished."

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YERSON STEEL-SERVICE

tries; and so on—all significant as metallurgical engineering achievements and as having a profound effect on the future.

The metal industries of the post-war period will be radically different from those of the pre-war era.—E. F. C.

Your Scrap IS Needed!

Last month the drive to collect industry's so-called dormant scrap really got underway, with steel industry, warehouse and sales executives associations cooperating vigorously with WPB's Industrial Salvage Branch in prying loose — from now until the war's end — every possible pound of metal tied up in machinery and parts that are idle and unusable in war production "as is."

This program to collect some 6 million tons of iron and steel scrap in the next 3 months is vital to the full utilization of the country's expanded steelmaking capacity in 1943. Operation of our steel melting furnaces at practical capacity is essential to full production in munitions plants. And anything short of maximum armament production is just plain welching on a lot of young men in uniform we all know.

Elementary? Flag-waving? Perhaps, but the fact remains that a dismaying number of plants still seem completely ignorant of the Nation's need for their scrap, and are heedless of persistent urgings to find and move it. The presence of piles of unmoved and unsorted scrap in yards and depots has been one reason for this state of mind, since many plants infer from this that no scrap shortage actually exists at the mills. This last is, in a sense, true — at the moment the steel mills have comfortable scrap inventories, but the dormant scrap is being sought *for later* rather than *for now;* it takes months to move, sort and process the scrap, and in the Spring and Summer of 1943 our steel mills will require millions of tons more scrap than in any comparable earlier period. And if that scrap isn't collected now, it won't be ready in time.

Mostly, though, the currently non-participating plants are just procrastinating. Once they look the scrap facts squarely in the face, the expected steps will surely be taken in each instance — appointment of an *executive* with full authority to throw out anything he deems scrappable; a thorough, hard-boiled survey and inventory under his direction of every idle or unusable part, tool, jig, fixture, machine and structure in the shop; orders to collect it all and sell it to a commercial scrap dealer; and continuation of the program as a *permanent* part of the plant's operations.

You who read this magazine, working almost entirely as you do in the *metal*-consuming or *metal*-producing plants, and occupying engineering and executive positions of authority, are nearly unique in your power to push the Nation's dormant scrap piles toward the sky, if you will.

Will you? —F.P.P.

Our Industrial Manpower

As this is being written, manpower would appear to be our bottleneck in war production generally, just as raw materials was the problem of the hour a few months ago. As to materials, we are now being assured that, save for but very few items such as rubber, our supply is definitely sufficient for military requirements, thanks to alternates and the spreading thin of our alloying materials.

It is to be hoped that within another six months the same satisfactory supply condition will exist in manpower. Probably the phase of most current concern is the lack of highly trained technicians and executives, such as receive four or more years of technical college training, or the equivalent.

Yet some of this gap can be filled from the ranks, so to speak, or from those who have been receiving technical training in the shops since our defense and war days started. In this fast-moving era a man in a war plant probably learns as much in one year as in two or more years in normal slower-moving times, and

(Editorial continued on page 122)

Ten Silver Months

"THE CRITICAL YEAR" IN REVIEW

Almost a year ago, shortly after he became chairman of the very young and then quite unsteady War Production Board, Donald Nelson turned his back on the mistakes that had preceded him and vowed with these words to fashion victory from the opportunities that still remained:

"We've wasted the golden months, the months in which we could have expanded our steel industry, our chemical industry, our copper industry and all the others, so that we could have plenty of everything. But we still have ten silver months *— the months that remain in 1942 — and in them we can do things that we never thought possible."*

And things that we never thought possible *have* been done in these last ten shining silver months! "Things" that the commercial segment of the business press will this month traditionally and dramatically portray in pictograph and climbing curves . . . several million tons more steel ingots . . . one hundred per cent increase in aluminum output . . . so many thousand added fighting planes, engines and propellers . . . scores of new merchant and Naval ships . . . moving, significant accomplishments that add new lustre to the ten silver months — to 1942, "the critical year in the existence of the United States."

But *how* were all these production achievements made possible? What immense ingenuity, knowledge and technical pioneering combined to break all the bottlenecks, master all the new manufacturing methods, stretch all our strategic materials to their utmost utility, make all our munitions of a quality that could move General Eisenhower to tell General Campbell in November: "Without doubt the U. S. Army has the finest weapons, ammunitions, tanks and other implements of warfare with which any army ever entered a war"?

Engineering — the world's best — is the answer! And in this issue is contained the systematized record of engineering progress throughout the war-vital metal industries in 1942.

This engineering review is divided into 5 broad sections, on (1) production of ferrous and nonferrous metals, (2) foundry practice in its five great branches, (3) metal-working and treating — all the fabricating and finishing processes, (4) materials and engineering design (new materials, new designs, metal-forms, non-metallics), and (5) testing, inspection and control.

Here are the real reasons behind the spectacular statistics of production and the reassuring record of military victories. How steel mill engineers revised their practice to fit new production requirements . . . the engineering background of the astonishing growth of the aluminum and magnesium industries . . . what technical projectile-manufacturing problems were solved in the forging field . . . how new heat treating methods allowed us to save critical materials . . . where the use of powder metallurgy and die casting eased the pressure on machine tools . . . what technical practices increased the tempo of industrial scrap salvaging . . . how ordnance was redesigned and re-engineered to save materials and machines . . . the new place of plastics and other nonmetals in the war-production picture . . . what new materials were developed in this first year of war . . . all these engineering steps to victory and scores of others of equal significance reported in these pages will make even the skeptic gasp "This *is* an engineer's war!"

Many, many months must pass before it will all be over. Nineteen forty-three and forty-four will have their own wartime problems and achievements. But the ten silver months just passed will be emblazoned in the pages of history as the months in which the production crisis was overcome — in which, indeed, the war was won — by America's engineers!

—The Editors

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ENGINEERING REVIEW OF '42

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Production of Metals

Tapping a blast furnace. (Courtesy: Ford Motor Co.)

Blast Furnace Practice

by Ralph H. Sweetser

Consulting Engineer, New York

The last sentence in my book "Blast Furnace Practice," published 4 years ago says, "In spite of occasional predictions to the contrary, the iron blast furnace process itself is not likely to become obsolete as the most economical process for the mass production of iron from its ores." I still stick to it.

However, there has been such a *furor loquendi* in Washington this past year about "sponge iron" that blast furnace men should say something about it even though they do not consider that the blast furnace is presently threatened with obsolescence or soon with "complete elimination."

Sponge Iron in the Blast Furnace

The fact that the iron blast furnace produces sponge iron inside itself continuously is not generally known to laymen but has been demonstrated many times to blast furnace operators. Only four factual cases will here be cited:

No. 1—The lining of No. 2 blast furnace of Algoma Steel Co. wore out so thin just above the bosh line that the whole inwall and top wall telescoped and settled quietly while in full blast, just as had been expected for several weeks. The furnace was emptied of iron and slag and the stock was drowned out at once. As the cold wet stock was pulled out at the tuyeres, solid iron in all phases from globules and chunks of almost pure iron low in carbon and high in sulphur, back to partially reduced lumps of iron ore with splotches of the bright red and yellow colors of the oxides, were clearly seen, hastily examined and taken away to be filled back into the furnace. There was no time nor talent to make a research job out of this unusual opportunity.

No. 2—A newly lined blast furnace, after six weeks of smooth operation, "blew its top off" because we tried to smelt high-carbon flue dust by mixing it with clay and charging it raw into the furnace. All stock above the bosh line was thrown out, and the rest was flooded with water as soon as the cast was made. After all loose stock was rabbled out, there was an inverted "thimble" of sponge iron about an inch thick extending down from the bosh line to about 4 ft. above the tuyeres, with the same slope as the bosh walls and about 18 in. away. The space between the thimble, which was just like sheet lead, and the bosh walls was filled with the fine coke breeze of the clay and flue dust balls. The sponge iron "thimble" was tough and difficult to cut up. The furnace was cleaned out, repaired and in blast again inside of a week; and again no time for research.

No. 3—Several years ago a small blast furnace on the banks of the Ohio River had a terrific "slip" and "blew off the top" and threw out all stock down to the bosh. The cause was dirty, unscreened coke. This time there was a ragged column of "sponge iron" extending from just above one of the tuyeres up to about 10 ft. below the stockline.

These three cases of suddenly arrested full-blast operation are proof enough that sponge iron is produced regularly in the iron blast furnace.

No. 4—To make an internal examination of an iron blast furnace in full operation it is necessary to insert a water-cooled sampling tube that can take samples of the descending solid and fluid materials at the tuyere level. This was done and samples of iron in different conditions were withdrawn, varying from soft sponge iron up to drops of iron so hard that they would cut a file.

Sponge iron made inside a blast furnace is separated from the gangue of the ore and the ash of the fuel by fusion and gravity at the expense of being contaminated with more carbon and silicon than is wanted in steel, but about the right amounts for making iron castings. Any sponge iron charged into a blast furnace will come out at the iron notch as pig iron with its regular amounts of carbon and silicon.

Technical Progress

The events during 1942 that were remarkable for the technical progress in blast furnace practice were chiefly in the field of increased daily and monthly pig iron tonnages; the recognition of a 1200-ton daily capacity as the standard size of blast furnaces with actual tonnages of 1450 tons per day; the speed with which blast furnaces have been partly or completely relined. The saving of 15 days in relining the No. 1 blast furnace of the Youngstown Sheet & Tube Co., Indiana Harbor, by tapping out 614 tons of molten iron from the hearth instead of blasting out a cold salamander was pictured in the Sept. 7th issue of *Steel* (page 67).

Air conditioning for blast furnaces raised a controversy between the "bone drys" and the "three grains of moisture" advocates, and several installations were put in before the fundamentals were fully known, resulting in some erratic results and some questioning as to the advantages of moisture removal—just as in the days of James Gayley and his epoch-making dry-blast. Now we know that a certain amount of hydrogen in the blast is needed for optimum results as to pig iron tonnage and low coke consumption. This optimum amount of hydrogen can be calculated when all the conditions are known.

Open-Hearth Steel Making

by Leo F. Reinartz

Manager, The American Rolling Mill Co.,
Middletown, Ohio

The War Production Board demands more and more steel ingots. The quality and quantity of scrap iron available for open-hearth use is decreasing. Increased percentages of hot metal, due to enlarged blast furnace capacities, require special low silica, low moisture ores in increasing quantities at a time when such ores are rapidly disappearing. The open-hearth operator finds himself in "hot water" trying to reconcile these two extremes.

In times of peak production, there cannot be much experimentation in the open-hearth department. The demands of the production department make it necessary to rebuild furnaces with the least possible delay. The aim, therefore, is to follow orthodox methods of furnace operation and maintenance as closely as possible, and push furnace repairs to the limit.

Scrap Quality and Bottoms

Bad scrap, due to rust, enamel, galvanizing, tin and other coatings, babbitt, brass, and many other contaminations has made bottom up-keep an extremely difficult undertaking. Plants that have prided themselves on not having any steel go through their open-hearth bottoms for a third of a century have fallen by the wayside. The only solution to such condition is more rigid inspection and sorting of scrap in the dealers' or plants' scrap yards. A bonus to scrap handlers for alloy and non-ferrous scrap recovery is one solution to the problem.

The Army and Navy, as well as the Industrial Salvage Branch of the WPB, must help in selling the idea to fabrication plants, to segregate scrap at the source—especially turning and boring scrap. Several test cases have shown that, with sufficient patriotic interest on the part of the management of such concerns, this segregation can be made. In some instances, it may even pay dividends in the higher return for such sorted grades of scrap.

There are now great tonnages of turnings available that are going "begging" because steel plant managements fear to use them largely based on past experiences which meant trouble from oil, copper, brass, babbitt, and other contaminations. Also turnings are usually very bulky and hinder prompt charging of open-hearth furnaces. If turnings can be degreased, and then bundled with about 5 to 10 per cent of light clipping scrap, or shredded and briquetted, they can be used in the charges for most steels, except those of highest quality, in tonnages ranging up to 10 to 20 per cent of the total charge.

Some alloy turnings, such as S.A.E. 4330, can be satisfactorily bundled, if heated to a dull red heat before bundling, or they may be bundled with 10 per cent light clippings or sheet scrap.

Alloy turnings from S.A.E. 4340, propeller hub scrap, can be crushed in a Logeman baler and then charged in bulk into charging boxes for electric or open-hearth furnaces use. Such scrap will weigh from 1,600 to 2,000 lbs. per pan, and has proved to be a very desirable type of scrap.

It has been discovered in several plants that tin-can scrap, even in quantities as low as 1 per cent is detrimental to quality, and most open-hearth managements have "tabooed" the purchase and use of this scrap.

Solution to Bad Bottoms

In the open-hearth department the only solution to bad bottom difficulties, despite local interruption of schedules, is to discontinue charging furnaces from time to time to "wash" the bottoms with scale, sand, spar, pig iron or any other convenient material, and then build from 4 to 6 in. of new magnesite all over the bottoms and banks. In the end, cost will be decreased, total tonnage over a period of months will be increased, and quality will not only be maintained, but improved. In fact, in the manufacture of armor plate or cartridge case steel in open-hearth furnaces, it is absolutely essential to have heats charged on bottoms that will not "boil out" old steel in the finishing stages of a heat.

More and more when an open-hearth furnace bottom is damaged, rammed refractories are being used. They appear to hold up very well under extreme operating conditions.

The managements of some plants have increased the overall efficiency of furnace operations by the installation of a large number of steam jets, strategically located in checker chambers and flues to the stack to decrease the accumulation of dust which clogs up the checker chambers, especially when high percentages of hot metal, and oily turnings are charged into furnaces using producer gas, tar or oil as a fuel.

Pouring a heat of open-hearth steel. (Courtesy: American Rolling Mill Co.)

Few Substitutions for Supplies

To date, comparatively few substitutions have had to be made in open-hearth supplies and materials. Aluminum and ferromanganese have been conserved without resorting to other materials. There is a pronounced shortage of high quality fluor spar. Lower quality spars are being tried out. In some cases, fine ore or scale may partially replace fluor spar as a furnace addition. There may have been some deterioration in brick quality, but I believe refractory brick of various types are much better from a quality standpoint than during the first World War. It is hoped our refractory manufacturers will be able to maintain this quality. Chrome brick and refractories are not readily obtainable but up to date sufficient quantities have been available for most urgent needs.

The influence of the personnel factor in open-hearth production is a very serious one due to Selective Service taking many of the young, live-wire first and second helpers for war service.

It has been found necessary to institute training classes for the new men who are now operating open-hearth furnaces. This training includes classwork, and training on the job. As the war continues to take more and more skilled men into the services, this training program must be amplified and improved if we hope to maintain production at any rate near to capacity.

These are days that try the operator's souls, but at the same time, they challenge them to match the soldiers and sailors' bravery and endurance by using their best endeavors to solve the multitudinous personnel and operating problems that present themselves each day. By courageously facing the problems of the day, we gain strength and determination to go ahead.

Let's remember: "If we are going to gain ascendancy over our enemies, we must maintain open-hearth production despite all handicaps."

Electric Furnace Steels

by W. J. Priestley

Electro Metallurgical Co., New York

Efforts to conserve critical alloying elements (while increasing steel output and maintaining steel quality) keynote the production of electric furnace steels and influence their composition. This applies to the high-alloy austenitic steels and to the low-alloy steels for general engineering use and for armor plate.

Austenitic High-Manganese Steels

An austenitic 16 per cent Mn type of steel has accordingly been developed to replace the austenitic chromium-nickel types for many structural uses in airplanes or in other mobile units having light, high strength structures. The manganese that is used, although a strategic metal, is considered to be less critical than the chromium and nickel which it saves.

No chromium whatever is needed in the high-manganese austenitic steel if the intended structural application can be adequately protected against atmospheric corrosion. The same type of steel with a 3 per cent Cr has improved resistance to progressive rusting, and 12 per cent Cr gives good resistance to corrosion by atmospheric attack.

With a carbon content in the neighborhood of 0.10 to 0.35 per cent, all three of these compositions give strengths, ductilities, and welding and forming characteristics comparable to those of the best chromium-nickel stainless steels. Cold-rolling improves their yield strengths to a similar degree, and their yield strengths and ductilities are likewise amenable to improvement by a 16 to 24-hr. stress-relief treatment at 200 deg. C. (392 deg. F.)

Corrosion-Resistant Steels

For many applications requiring resistance to corrosion and strength characteristics comparable to those of the 18-8 chromium-nickel type steels, increased consideration is being given to a type of stainless steel that differs from the 18-8 Cr-Ni type in that manganese (and possibly some copper) replaces a major part of the nickel. A composition containing 18 Cr, 6 Mn, 4 Ni, 1 Cu, and 0.10 per cent C is typical of this type of steel, although the percentages of the various elements can be varied somewhat in accordance with the requirements of the intended application.

This steel is predominantly austenitic, but it contains enough ferrite for good hot-working characteristics and for a balanced structure that is less susceptible to intergranular corrosion after welding than is the straight 18-8 Cr-Ni steel. The austenite in the metal provides cold-working characteristics nearly equal to those of a completely austenitic steel.

The high manganese content of the steel facilitates fusion welding by improving the fluidity of the slag and protecting against loss of chromium and against carbon pick-up in the weld metal. It also gives the steel better resistance to the attacks of sulphur dioxide and of many other chemicals than is possessed by the 18-8 Cr-Ni type of steel.

Another type of stainless steel that seems desirable from a conservation standpoint is one containing 23 Cr, 4 Ni, 0.25 to 0.30 per cent N, and a low carbon content. Despite the low nickel content, the unusually high percentage of nitrogen makes the steel austenitic, and its corrosion resistance and welding characteristics are good. A manganese content of about 3 per cent is desirable for best properties in this steel.

New Steels Conserve Virgin Alloys

In the production of the lower alloy electric furnace steels, also, efforts to conserve alloying elements have been fruitful. Current recognition of the truth (as expressed in some of the NE steel compositions) that a small total percentage of several alloying elements is more beneficial to the general properties of steel than a relatively large addition of a single alloying element has led to the specification of satisfactory steels with unusually low alloying contents. Through the use of alloy steel scrap to supply the major part of the alloy specification, it is possible to conserve substantial amounts of virgin alloys.

Boron Alloys and Deoxidizers

The use of ferroalloys containing boron, which is a non-strategic element, makes possible a further saving of the conventional alloys. Although the effect of boron on the hardenability of steel is similar to that of other alloying elements used to increase hardenability, boron is unique in that minute amounts are exceptionally effective. Additions of the order of 0.001 to 0.003 per cent B give optimum results while additions of only 0.0006 per cent have been reported as definitely beneficial. Additions of 0.010 per cent are ordinarily considered excessive and possibly even detrimental. Because of difficulties in making quantitative determinations of boron in steel, calculations are based on the amount added and not on the amount of boron residual in the steel. It is obvious, however, that losses of the boron through oxidation must be limited and constant if the results of boron additions are to be satisfactory and predictable. The additions must therefore be made to a steel that is well deoxidized.

Thorough deoxidation of the steel also helps to limit oxidational losses of other alloying elements. For this reason the subject of deoxidation has received particular attention. It is becoming common practice for aluminum as a deoxidizer in electric steelmaking to be partially replaced with calcium-silicon or calcium-manganese-silicon. Not only do the non-strategic elements in these alloys help to conserve aluminum, but their use as final deoxidizers in place of a portion of the aluminum generally gives better ductility to the steel.

When boron is added, there is considerable evidence that the boron is most effective and gives most nearly uniform results when the boron addition is made in the form of a complex alloy containing several deoxidizers—such as silicon, calcium, titanium, and zirconium. Aside from the added protection afforded the boron by the accompanying deoxidizing elements, they serve to dilute the boron so that its addition in less concentrated form promotes uniform dispersion throughout the steel.

Copper and Brass

by R. A. Wilkins

Vice President, Revere Copper and Brass, Inc., New York

Engineering progress, research and development work in the copper and brass producing industry have in the past year followed the course and direction indicated by the problems presented to the industry in meeting and aiding the war program. The primary requirement placed upon the industry as a whole has been to produce in large volume standard items of copper and copper alloys required by the manufacturers of munitions and essential equipment and to co-operate with various government agencies in the allocation of available production to meet major requirements.

With the supply of metal inadequate to meet fully military demands and the demands of essential wartime industry for copper and standard copper base alloys, there has been little stimulus to research or development work conducted for the purpose of introducing new or special alloys. The efforts of technical, as well as production personnel, have been concentrated on volume and on the maintenance of adequate quality.

It is not surprising, therefore, that the past year has seen little, if anything, in the way of new alloy developments.

On the other hand, the requirements of war-time industry and the inadequate supply of copper itself have brought to technicians within the industry many interesting problems incidental to efforts to economize on the use of copper and to develop products which could function in the place of copper or its alloys.

Perhaps the most spectacular instance in this latter field of effort is the rolling of large tonnages of silver bus bar. From a metallurgical or production point of view the introduction of silver as a tonnage item in the brass mill has presented no serious problems. The rolling of millions of pounds of silver bus bar on a commercial scale does, however, in view of the monetary value of the metal, constitute an interesting departure from standard practice and operations.

Another application of silver which possesses more general technical interest is that of a silver bimetal with steel used in the production of high quality bearings for use primarily in airplane engines. Concomitant with this development has been some experimental work with pure oxygen-free copper in the form of bimetal with steel for similar application in less critical services.

Both of these applications of bimetal present cases where there is a real functional value in the product and are not efforts to realize a dollar economy which bimetal so frequently appears to afford, but so seldom does.

Another much more extensive application of bimetal is that of a gilding metal combination with steel for use in bullet jackets. Here we have no apparent functional value of the product to sustain it in comparison with solid gilding metal, nor do we have any tangible monetary economy. The function of bimetal in this application is the saving of copper as a strategic metal. For this material economy to be realized in any substantial degree, the satisfactory recovery of copper from scrap bimetal is essential.

Various processes have been suggested and considerable development work has been performed in this field. It would appear that satisfactory methods have been developed for the recovery of copper from copper bimetal scrap or gilding metal bimetal scrap.

Some Salvage Problems Solved

In addition to efforts to economize in the use of copper by the above mentioned applications of silver and uses of bimetal, there has, of course, been an intensive effort to salvage copper and copper alloys from existing materials not suited to direct use in war production.

The alloys of copper, nickel and zinc, both leaded and unleaded, are produced extensively in the brass mills for purposes of normal, peace-time manufacturing. Large quantities of such materials are available, but are not susceptible of direct remelting for use in the production of cupro-nickel, which is the only nickel alloy of war-time significance generally produced in copper and brass mills.

As is well known, the separation of copper and nickel presents difficulties in the copper refinery and in the existing situation such a complete separation is not necessary. A process has been developed for the treatment of salvage material and scrap material consisting of copper, nickel, zinc alloys, both in the leaded and unleaded condition.

Equipment has been designed and a plant is being erected for the application of this process, which is designed to convert such materials to the form of copper-nickel alloy ingot suitable for use in the production of cupro-nickel condenser tubes. An incident to the process is the direct recovery of zinc as metallic zinc.

An ingenious scrap collecting campaign was instituted by the Paper and Twine Club for the collection of unused keys. This campaign met with considerable public response, with the result that several million pounds of old nickel keys have been collected, thus rendering available a considerable tonnage of cupro-nickel from an unanticipated source.

It is quite apparent from the items mentioned briefly above that the brass mill technician has been, by force of circumstances, active in fields somewhat beyond his normal range of activities.

Perhaps the broadest departure of all has been the drawing of steel shell cases by fabricating units of the copper and brass companies.

The Past and The Future

It is certainly true that war-time requirements have introduced the fabrication of copper and brass items to many companies and to many men who have hitherto been unfamiliar with these metals and it is equally true that the manufacturers of copper and brass have by reason of war-time requirements and necessities extended their interests into fields that are somewhat novel to them. War-time necessities impose the requirement that all available equipment and man-power be used to the maximum advantage.

It is perhaps not surprising, therefore, that in a discussion of the copper and brass field in the year 1942, our attention is directed, not to new alloys of copper and new applications of such alloys, but rather to silver and its manufacture; to bimetal; to the fabrication of aluminum and magnesium—even to the drawing of steel. Within the industry it is natural that all efforts are directed to supporting the war effort. It is of interest to consider, however, the possible effect of our present enlarged scope of activity upon a post-war production of materials.

It seems only reasonable to conclude that current activities will lead to a variety of interesting new developments and new products in a post-war era.

The White Metals

by Edwin F. Cone
Editor

Casting molten aluminum into pigs. (Courtesy: Aluminum Co. of America)

This brief article is the result of an interview with a leading authority in the non-ferrous industry.

The past year has kept metallurgical engineers busy finding substitutes for one metal after another and then finding substitutes for the substitutes which, in a few annoying instances, resulted in the resubstitution of the metal originally employed. All of which means that our supply of practically all metals is not sufficient for both military and what we feel are essential civilian needs, this in spite of an unprecedented increase in production of practically all metals with the possible exception of tin. Of the common metals only lead appears to be available in quantities sufficient to take care of all military needs, and essential civilian needs including some substitutions for other metals.

Fabricating Special Alloys

When it became evident that the Japanese would control our most important source of tin and that we would have to plan on less than half as much tin as we would normally consume, a campaign of bold substitutions was entered which is continuing to the present with surprising success. It has been demonstrated that properly engineered bearings using lead base alloys usually can replace satisfactorily tin base bearings and in a majority of cases substitution can be made without change of practice or design. Today there is no excuse for the consumption of any considerable quantity of tin in bearings.

The consumption of tin in solders has also been drastically decreased. The lead-silver solders have in some important uses proved to be superior to the conventional lead-tin alloys. However, the complete replacement of tin in solders is frequently impossible due to temperature limitations and the lead-tin-silver alloys most often constitute acceptable compromises. The collapsible tube industry has also learned to get along with very little tin by the use of tin-clad lead alloy slugs. The tin plate industry has accomplished miracles by making less and less do more and more chiefly through the production of electroplated sheet. As a result of the prompt action of these and other tin consuming industries guided and prodded by the W.P.B. it is probably safe to say that the need for more tin is today no more critical than the need for many other metals.

Zinc for Die Castings and Cartridges

The zinc industry was one of the first to feel the demand for more production particularly of special high-grade zinc suitable for die-castings and cartridge brass. Even the marked expansion in the production of the high-grade zinc has failed to fully meet the needs and anticipated needs for this metal for military requirements and the die-casting industry is now undertaking to use lead-base alloys as a substitute for zinc-base alloys wherever possible for military uses just as was done a year ago for civilian uses. Many substitutions can be made if cost is not the primary factor but inferior physical properties prevent indiscriminate substitutions. Likewise, the substitution of lead-base coating alloys for steel in place of galvanizing is being reconsidered in view of anticipated shortage of even the lower grades of zinc. Here for a few special uses lead-coated steel is superior to the usual galvanized steel but for general application its use will be merely a temporary expedient.

Lead Relatively Plentiful

As has already been pointed out lead is in an enviable position in that there is sufficient available to take care of all essential requirements for the normal uses of the metal and in addition it has played an important role in replacing tin and, to a lesser extent, zinc. Even copper has been replaced by sheet lead and pipe and where the new creep resistant lead alloys have been used the substitution has been effected without increase in cost or decrease in serviceability. It now seems certain that the availability of lead and its ease and speed of fabrication will lead to many new war-time uses, particularly as the wide range of properties obtainable with lead alloys becomes known.

Cadmium Rationed

For three or four years before the war there was barely enough cadmium to meet the demand although the production of this metal has very nearly tripled. Now the war-time needs for this versatile metal has necessitated the strictest rationing and the use of it is permitted only for the most essential military purposes where substitutions are impossible.

Early in the year a shortage of antimony threatened possibly due to hoarding. While the supply and demand for this metal is never very steady, at present the situation seems well in hand and ample antimony is available for essential needs. The substitution of lead-base babbitts for tin-base babbitts has increased the need for the metal for bearings to some extent but the decreased needs for grid metal more than compensates for this.

Bismuth has been, at least until quite recently, fairly plentiful and has been regarded as a possible substitute for tin, particularly in solders. However, the war demands have been slowly decreasing stocks. If new demands for special solders containing bismuth are developed, it is conceivable that available stocks may be wiped out.

Aluminum and Magnesium

by Harold A. Knight
Associate Editor

Rapid and mammoth production was the stand-out feature of the aluminum and magnesium industries in 1942. The United States produced last year more than 500,000 tons of aluminum, according to the annual statement of the Aluminum Co. of America, which predicts that the peak capacity in 1943 will be 1,050,000 tons annually.

WPB spokesmen agree that 1943 production of magnesium will reach 300,000 tons, as against 130,000 tons yearly, the estimated rate as 1942 ended. The annual rate the month before Pearl Harbor was 24,000 tons. Annual consumption in 1939 had been 3,225 tons.

Aluminum

Commitments for the aluminum expansion program aggregating $737,391,674 have been made by the Defense Plant Corp., RFC, according to a WPB statement made in late December. This includes "construction of 12 plants for the production of aluminum which, together with the capacity of privately-owned plants and what we are able to buy from Canada, will provide sufficient aluminum to meet our requirements. Nine of these plants are in at least partial operation, and will be completed in a few months."

There were no important technical developments in the production or break-down fabrication of aluminum and its alloys during the year (although developments in their forging, heat treating, machining, welding and finishing—described in other articles in this issue—were very numerous indeed); all efforts were concentrated on volume-production. Last year we produced more aluminum than all of Nazi-controlled Europe. This is an important statement when it is realized that Germany has been a notable aluminum-using nation, and by necessity so, for she had access to much aluminum but was hungry for copper. U. S. production was probably eight times as much as Japan's.

One of the major reasons for our rapid expansion was standardization in design, which is particularly feasible where a tremendous tonnage of product is needed. Seventy-two large buildings were constructed from the same set of shop drawings. An order given to one manufacturer for 175 six-ton cranes, all identical, for use in aluminum plants allowed crane manufacture 50 per cent faster than normal.

A second reason for production records was the development in previous years of our many water power projects, allowing aluminum manufacture, previously confined to the East, to spread well over the country and to the Pacific Coast.

Finally, all our aluminum capacity should not prove to have been built up in vain, come peace. Its price, now 14 and 15 cents per pound, may drop to 12 or even 10 cents, or less. At such a price it could capture many steel markets, particularly in the transportation field. In railroad structural steel use, steel can be replaced by one-half its weight in aluminum alloy. Thus, at 2 cents per pound for steel and 10 cents for aluminum, the latter might prove by far the more economical—not from standpoint of original cost, but of the ton-miles carried economically. If railroads, shipbuilding and automobiles (not to mention airplanes) use aluminum to their saturation point, our present stupendous facilities will be strained.

Magnesium

The production revolution that has taken place in magnesium has been much more than "statistical." Whereas the aluminum expansion has involved no basically new production processes, a large proportion of the new magnesium capacity represents the introduction and use of magnesium-producing methods not employed in this country before 1941 (and some of them not used *anywhere* before then).

Two years ago Dow Chemical Co.'s electrolytic process—in which fused 85 per cent magnesium chloride recovered from locally available brines is electrolyzed—was the only magnesium-producing process in use in America. Since then—and especially in 1942—at least three other processes have come into important use, while a fourth (the Hansgirg process for thermic reduction of calcined magnesia with coke) has apparently fallen by the wayside because of its technical deficiencies.

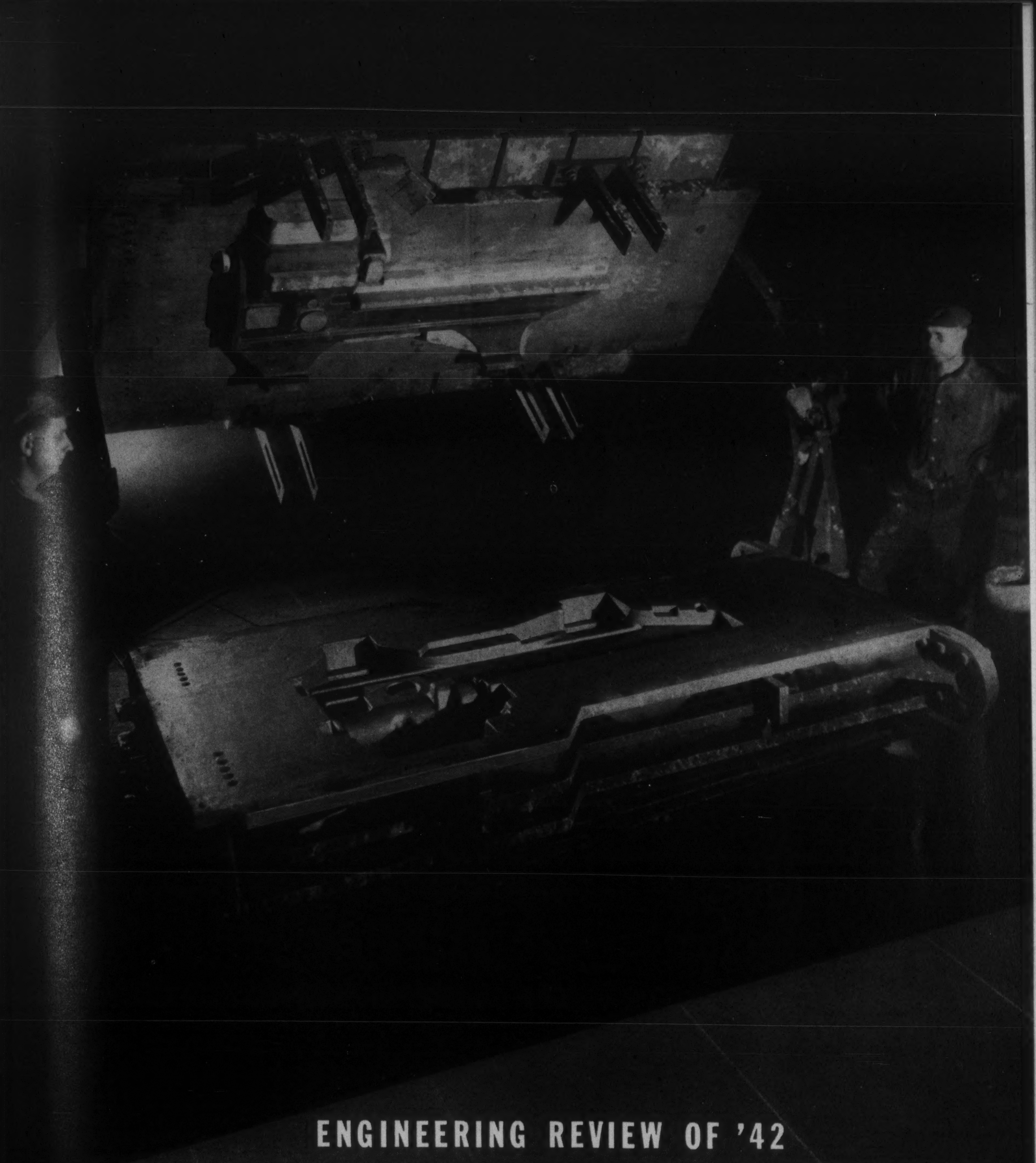
The first of the three surviving (and doubtless permanent) processes that have given this country a new major metal industry is Dow's magnesium-from-seawater method, now producing over 18,000 tons per year at Freeport, Texas. In this process, enormous amounts of seawater containing 0.13 per cent Mg are treated with hydrated lime to give a precipitate of magnesium hydroxide, which is chemically converted to 85 per cent magnesium chloride, fused and electrolyzed in the Dow cell.

Another electrolytic process of major importance is the M.E.L. (Magnesium Elektron, Ltd.) cell, in which fused magnesium chloride (prepared by calcining high-grade magnesite and chloridizing with chlorine obtained from the magnesium cells) is electrolyzed. The magnesium chloride must be anhydrous if the M.E.L. cell is to function at maximum efficiency. In this country a relatively new company, Basic Magnesium, Inc. (now controlled by Anaconda) went into large-scale production using this process in August 1942; its rated annual capacity is 56,000 tons of metal.

The third important new process is the ferrosilicon reduction process, in which calcined dolomitic limestone (calcium-magnesium carbonate) is heated and reduced with ferrosilicon in a vacuum at 2100 deg. F. The reaction takes place in alloy retorts, at the cooled end of which the vaporized magnesium condenses. The process need not employ electrical power for its operation (although power *is* needed to make the ferrosilicon) and is simple and relatively foolproof. One of its greatest problems has been that of obtaining the nickel-chromium alloy retorts believed necessary for efficient production.

At least four North American companies are now in production using this process (usually credited to L. M. Pidgeon of Ottawa, Canada)—Dominion Magnesium Co., Ltd., New England Lime Co., Permanente Metals Corp. and Ford Motor Co. The Ford installation employs some original departures from the usual ferrosilicon process that make it of special interest—*e.g.* the use of air-cooled rather than water-cooled retorts, the use of easily removable condensate sleeves, etc.

By the time this is published other companies than those listed (*e.g.* National Lead Co. and American Metal Co.) will have entered the lists of new magnesium producers in actual operation. All told, it is an inspiring spectacle of American enterprise and engineering accomplishment that must bring little comfort to the already-squirming Axis.



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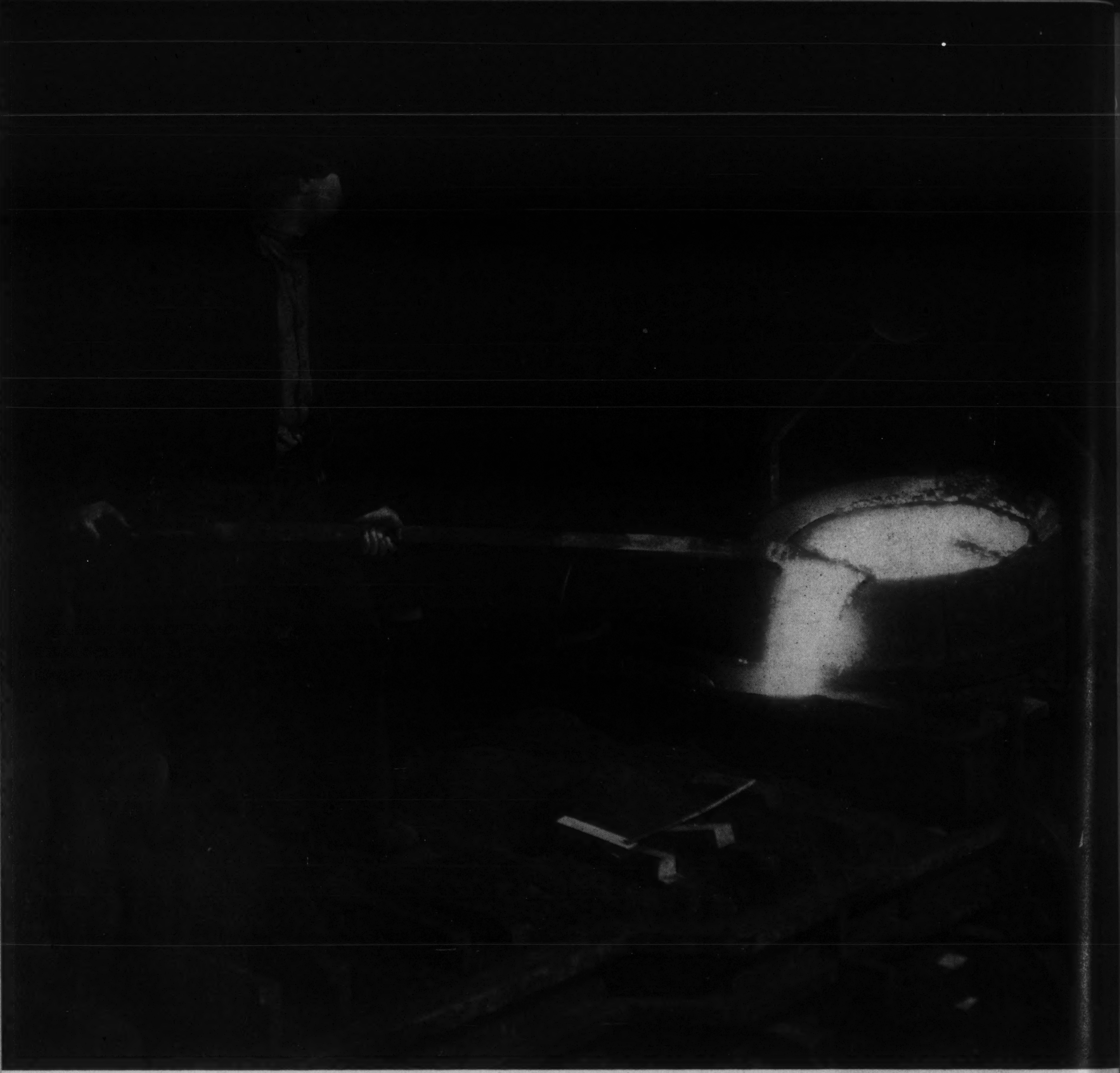
Foundry Practice



Pouring a ladle of cast iron into a mold. (Courtesy: Warner & Swasey)

Gray Iron

by C. H. Lorig

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The restrictions on the use of critical alloying elements, and the necessity for using scrap which formerly would not have been accepted for cupola charges, have affected profoundly current gray irons and their applications. Faced with a shortage of many materials and obliged to use others not entirely suited to its operations, the gray iron industry has shown much resourcefulness in adjusting itself to the changed conditions. Technical developments in the industry this past year have been largely a matter of meeting the scarce metal situation.

Without the unlimited supply of alloying elements characteristic of pre-war days, the drift in composition of gray irons has been sharply toward lower contents of alloys and even to the elimination of the critical materials from many analyses. These changes in composition are being accomplished without affecting either the quality or the mechanical properties of the iron. More consideration is being given to the base composition and in particular to the carbon content, for it is now being recognized that the influence of carbon predominates over all other constituents.

Control of Carbon

Carbon, present in cast iron partly as graphite and partly as combined carbon, exerts a powerful influence on engineering properties not only because of its proportion in the iron but because the structural state of the graphite is exceedingly important. Control of the carbon as to amount as well as to the structural state of the graphite has now become a primary objective in the manufacture of quality gray iron. Other things being equal a change of 0.10 per cent in carbon of gray iron will account for a change in tensile strength of from 2000 to 4000 lbs. per sq. in.

Many gray irons respond to ladle treatments, hence the adding of so-called inoculants or alloys of the deoxidizing type to irons in the ladle to effect a more favorable structural state of the graphite in the casting has become almost universal. Heat treating and flame hardening are also being practiced on an increasing scale, with the result that gray irons for various engineering applications are being extended into new fields with marked success.

The achievements of the industry in supplying modern irons of superior properties from the none-too-good scrap reflect the painstaking attention paid by operators to details of melting and production. The exercise of better control during melting has made possible the manufacture of castings which are uniform and in no way inferior to castings made under less trying, pre-war conditions.

Improvement in Quality

These experiences will go far in stimulating a rapid improvement in the general level of quality of castings. They forecast a new era in which gray iron will achieve unprecedented engineering importance. While their use in modern war material is still limited, efforts are being made to use gray iron castings wherever possible so long as military efficiency or safety are not affected.

A shift from critical materials to less critical gray iron in ordnance has already taken place in several instances, and other similar changes are contemplated. Not only can gray iron replace steel in certain applications, it has also been found that gray iron can frequently replace non-ferrous metals without affecting the functioning of the part. Thus a serious effort is being made to use gray iron so as to release scarce metals for other war uses.

Steel Castings

by Charles W. Briggs

Technical Adviser,
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Production has been the keynote of the steel casting industry during 1942. The total output has been in excess of 2,000,000 net tons. This is approximately 40 per cent above the 1941 production and considerably over twice the 1940 production. The present annual capacity is almost double the normal steel foundry industry capacity.

Plant Expansion and Conversion

More than half of the steel foundries have made additions to their plants to provide for increased output. A number of the foundries have built complete foundry units. A few organizations, new to the industry, have put up steel foundries. Approximately 20 gray or malleable iron foundries have converted their facilities or a part of their plant to the production of steel castings.

Plant expansion is not as yet complete and a number of the larger units will not be in complete production for another two or three months.

Most of the steel castings produced have been for the Army, Navy, Maritime Commission and Lend-lease. During the first part of the year the railroads took something less than their normal quota of railroad specialty castings. Steel castings have also been furnished to shipbuilding organizations under Lloyds and American Bureau of Shipping requirements.

The country has been advised of the large quantities of cast armor castings that are being produced primarily for tanks. This has been an undertaking of considerable magnitude because of the numerous technical problems and difficulties connected with obtaining maximum speed of production.

For the Army and Navy

Castings have been produced in large quantities for the Army. These include tank castings of all types including armor, as well as gun mounts, anti-aircraft gun and detector castings, Barbette and gun carriages, breech rings, combat and scout car castings, pontoon bridge and life boat carrier castings, recoil mechanisms, machine gun castings and aeronautical castings of different types.

Castings being produced for the Navy in quantities consist of various items of ordnance equipment such as fire control castings, gun castings and shields. Ship castings of all types have been produced in large numbers. A few of these types may be mentioned such as boiler, compressor and pump castings, engine and hoist castings, anchors, propellers, rudder and stern castings, valves and turbine castings.

Technical developments in the steel casting industry during the year have shown that considerable emphasis has been placed on steel making methods and conditions. The iron foundries converting to steel have largely accepted the converter and run a duplex operation. In some cases a triplexing practice of cupola-converter-electric furnace is used. The latter is being proposed for installations requiring continuous pouring.

A Comeback for the Converter

The converter is staging quite a comeback in the foundry because it can be so handily used in conjunction with the cupola. Also, the scrap steel situation is such that larger quantities of pig iron can be used. The sulphur can be lowered appreciably by the soda ash treatment and some very interesting experiments are now going forward on reducing the phosphorus content in the cupola. Furthermore, during the year the industry and steel casting users were advised by Sims and Dahle in METALS AND ALLOYS (July) that converter steel had properties similar to cast steels made by other processes.

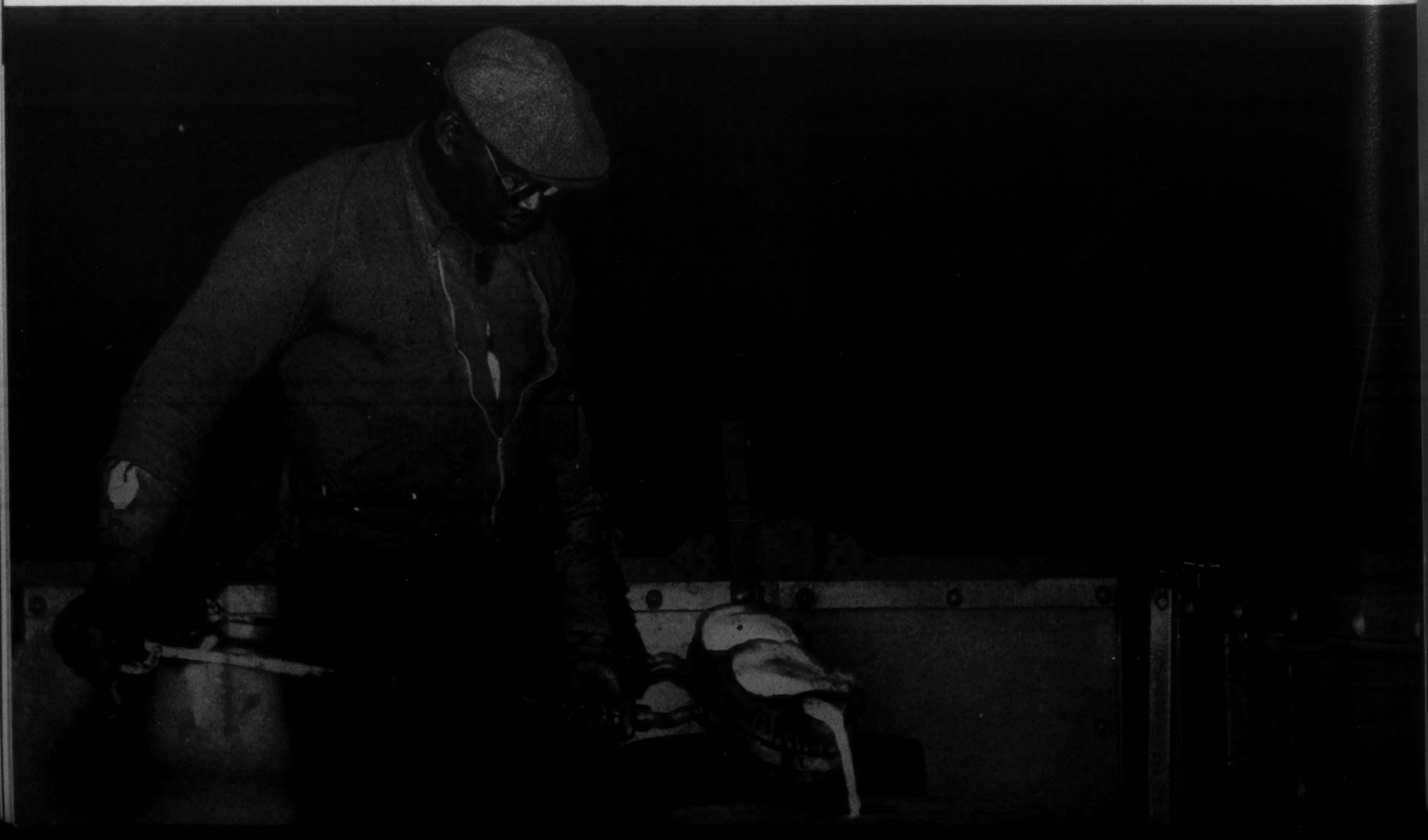
Casting producers using electric and open-hearth processes have reviewed methods because of the poor character of the scrap obtained and the step-up in production. Information presented by J. J. Juppenlatz on acid electric slag control and material developed by C. W. Briggs and G. F. Baldwin on the acid open-hearth practice has been of considerable aid in developing the processes.

More Centrifugal Castings

The airplane manufacturers and the Army Air Corps became much interested in centrifugally cast steel castings during the year with the result that a number of units have been installed at various foundries. Approximately 20 steel foundries have centrifugal casting units. Many of the units are being used at the present time in an experimental manner but it is believed that during the coming year a sizable tonnage of steel castings will be produced centrifugally.

Additional heat-treating equipment has been in demand during the year, especially the equipment that lends itself to routine operations of quenching and tempering. The entire steel castings industry has increased considerably the amount of tonnage given a quenching and tempering treatment. The staff of nearly all steel foundries have carefully reviewed the metallography and heat treatment of cast steel as prepared by the Steel Founders' Society of America and have made changes to assist in the speeding-up of production of castings without loss of quality for the war effort.

Pouring steel into centrifugal machines for casting gear blanks. (Courtesy: Ford Motor Co.)



Malleable Iron Castings

by James H. Lansing
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Cleveland.

The engineering developments of probably greatest interest and value in the malleable industry during the last year have to do with the application of malleable iron to armament uses either in replacing strategic or critical materials or in effecting outstanding savings in time, material, and cost.

With war changes in industry, many manufacturers and engineers whose past experience had not been such as to well acquaint them with the possibilities of malleable iron castings, found themselves confronted with the problem of rapidly getting into large volume production of armament components. Seemingly insurmountable obstacles appeared to exist in the inability to obtain bronze or steel castings, or to obtain the required number of machine tools. Here, in ever so many instances, malleable iron developed to be the answer to both problems.

In Army Jeeps, Trucks, etc.

In the automotive industry engineers have had a long and favorable experience with malleable iron. They know that it is tough, will stand the shocks of severe service, and yet will machine with greater ease than any ferrous product of comparable physical properties. In military vehicles, therefore, they were quick to point out its advantages to army engineers and to specify its increased use. With the requirement of front, as well as rear, wheel drive, malleable axle use has been doubled in differential carriers, cases, and bearing caps. New steering problems, involved in the driving front wheels, have occasioned the use of additional steering knuckle parts of malleable iron. Many malleables go into the construction of jeeps, peeps, half-tracs, tanks and army trucks.

An excellent illustration of the advantageous application of malleable iron is in the case of a 16-lb. anti-aircraft gun grip. This part was formerly made up of forged parts on which there was necessitated a metal removal loss of 73 per cent. Substitution of malleable iron parts reduced metal removal to 32 per cent. Thus were saved machine tools, man hours, valuable metal, cost, and time. Another example is a mortar gear case which originally was machined from a solid forging. Samples were made in malleable iron, submitted to the Government and passed all tests. Again, important savings were made in time, tools and metal.

Substitute for Bronze Castings

Among noteworthy substitutions for bronze castings have been the use of many malleables on the Oerlikon gun mount. A great saving in a strategic material and in cost has thus been effected. With malleable use, it was not even necessary to reduce machine speeds and feeds. Another similar saving was made in the use of malleable iron in place of bronze in landing boat steering gear assemblies.

In machine gun mount pintles, in cargo vessel air port covers, in tractor parts, in chemical warfare equipment, in heavy gun bases and tank conveyor propeller mechanism parts, malleable iron has advantageously replaced critical steel castings and given complete satisfaction in service. The required production has thus been maintained.

Adapters for anti-aircraft shell were originally machined from solid bar stock with a consequent large wasteage of machine tools, metal and man hours. The original bar stock weight per piece was 3.75 lbs., this being machined down to a finished part weight of 1.50 lbs. each. A metal loss of 2.25 lbs. was thus involved in the production of each 1.50-lb. part, and many men and machine tools were tied up in the work. A malleable iron casting was then designed with an original weight of 2.25 lbs., thus saving 1.50 lbs. of metal, in addition to time and tools on every part produced. And, necessarily, the production runs to millions.

Another large production part on which great metal saving has been made possible is the eye bolt lifting plug used in handling shell. On a part weighing approximately 2 lbs., ½ lb. is saved on each part by substituting a malleable iron casting for a forging. In the case of the malleable iron plug, it is possible to core out ½ lb. of metal without in any way affecting the utility of the part.

In Railroad Journal Bearings

In railway applications, advantage has also been taken of the properties of malleable iron in conserving strategic materials. An example of this is the use of malleable iron backing castings to replace a large amount of copper bronze in railroad car journal bearings. Tests have established that such bearings are reliable and in them a malleable iron backing casting, weighing between 9 and 10 lbs., replaces an even greater amount of copper bronze.

Advantage has also been taken of possible redesign of parts and reduction of section thickness to conserve critical aluminum, and yet furnish a casting but slightly heavier than the original. One company reports a bracket casting in which the original in "light" aluminum weighed 2.10 lbs., and the redesigned part in "heavy" malleable but 2.60 lbs.

In pearlitic malleable iron, the Ordnance Department has taken advantage of a material which may well be specified when parts are subject to abrasive wear. In the case of these castings, some ductility and machinability have been sacrificed for higher hardness, yield point and tensile strength. An excellent example of such application is the top plate for a tank track. A considerably lower ductility pearlitic malleable has also found extensive satisfactory use by the small arms section of the Ordnance Department.

Aluminum and Magnesium Castings

by Norman E. Woldman

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Increased demands of the aviation and allied industries in the war effort have caused ever increasing production of aluminum and magnesium alloy castings in our foundries. More and more essential in aviation are the light metals which, by decreasing weight, increase load carrying capacity, speed and maneuverability. Heavier production has involved the necessity for improved techniques to minimize rejections from normal foundry casting defects. Continued research has brought forth information enabling the foundries to produce sounder and denser castings.

Removing a crucible of magnesium alloy from a furnace before pouring castings. (Courtesy: Ford Motor Co.)

Aluminum and magnesium casting alloys have changed very little during the past year. Research, however, has continued to improve the alloys. The impurities which cause pitting corrosion and which affect the response of the alloys to heat treatment have been identified and can be controlled by proper procedures in the melting.

Greater production has increased the field of permanent mold castings for highly stressed parts and die castings for low stressed parts. The initial high cost of the metal molds and dies are now insignificant compared with the great saving in machining costs. Closer casting tolerances in permanent mold and die castings compared to sand castings mean less stock to be machined off with subsequent lower manufacturing costs.

High Pressure Die Castings

The development of high pressure die casting machines (pressure up to 35,000 lbs. per sq. in.) has encouraged the design engineers to lay out casting drawings suitable for die castings. Metallurgical and engineering tests have shown that high pressure die castings are sufficiently dense, sound and free from blowholes, porosity and shrinkage to warrant their use for certain highly stressed services. Some producers are now experimenting with new die casting machines having pressures as high as 60,000 lbs. The future for these castings looks very promising.

Formerly, aluminum die castings were made from the silicon type alloys which did not respond to heat treatment. Porosity in low pressure castings prevented them from being heat treated. This resulted in castings of low physical properties. High pressure die casting machines have enabled the foundries to use heat treatable aluminum alloys with excellent results. Now we can obtain die castings heat treated to high physical properties.

A new development in magnesium sand castings has been the injection of sulphur dioxide in the sand mold just before pouring to inhibit oxidation of the molten metal.

Magnesium Alloys Now Weldable

Another new development has made the welding of magnesium alloys possible. This welding process, known under the name of "Heliarc," consists of an electric arc produced and maintained in a controlled atmosphere of helium gas. A special type of welding unit permits the gas to pass through the tip surrounding a tungsten electrode and the arc is produced directly between the electrode and the base metal. The filler rod used is composed of magnesium alloy; however, no flux is necessary since helium (being an inert gas) prevents oxidation. The elimination of flux removes the danger of entrapped flux in the weld deposit which might later lead to corrosion. Magnesium castings containing foundry defects have been repaired with this process and welds equal in strength to the parent metal have been obtained.

"Secondary" metal from the refiners is being used more and more owing to lack of sufficient supply of virgin metal. The impurities are present in greater quantities and thus do effect the quality of the castings. The foundries, however, are getting around their difficulties by "sweetening" the secondary ingot material with some "virgin" metal to lower the impurity content.

Brass and Bronze Castings

by Sam Tour

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The critical shortages of new copper and tin have had a profound effect on the brass and bronze foundry industry. The entire industry has been forced to use secondary ingot metal and scrap metal as its raw material. It has been necessary to adjust compositions to lower tin ranges or substantially tin-free alloys and to lower copper content by increases in lead and zinc. The tin shortage has forced an increased use of the silicon-copper alloys.

The foundryman has been caught in the crossfire of "opinions" from many sources as to the value of this, that or the other alloying components and the effects of this, that and the other "impurity." Many of the "opinions" come from salesmen, purchasing agents, engineers, professors and young college graduates [and even editors, tsk, tsk!—Editor] with little or no foundry experience and an equal amount of factual knowledge, but with positive convictions and closed minds.

Through the course of years the large primary metal producers have been the principal source of the published and so-called "metallurgical information." They have efficiently increased the purity of their primary products, and it is only natural that they have stressed this purity. It is also natural that they have advocated specifications with impurity limits based upon this available purity of their primary products rather than on the actual requirement of the finished product. The question has not been "what is the effect of X impurity?", but "how long does X impurity run in an alloy made from primary metals?"

This sometimes biased information has been supplied freely to anyone interested, including the salesmen, purchasing agents, engineers and professors previously mentioned. It has been written into engineers' handbooks and college textbooks. Every new college graduate comes out armed with this textbook information and a brace of such handbooks. A brief survey of the normal methods used by authors of textbooks and handbooks to compile their information shows clearly that such books can be nothing more than repetitions of that information.

The Foundry Industry's Own Problem

Much useful factual information has been developed in the foundry industry. Much is contained in technical papers presented by foundrymen and experienced foundry metallurgists to technical societies and to the technical trade journals. Once presented and once published, the information is available to one who will undertake to dig into the literature.

But salesmen, purchasing agents, many design engineers, professors and young college graduates are not "diggers." They are receivers of free catalogues, free bulletins, free advertising literature and free advice. The foundry industry as an industry has been lax in its educational work among those men who really control the specifications written to cover the product of the industry. The primary metal producers have been more active educationally.

The situation in the critical metals during this war effort bids fair to go a long way towards correcting the situation. It is up to the foundry industry to recognize its opportunity to re-educate the misinformed and to get going under its own power. Impurity limits in specifications should be based on knowledge of the effects of the impurity on the properties of the metal and the service requirements of the finished casting and not on the quantity of such impurities present at the moment in available raw materials.

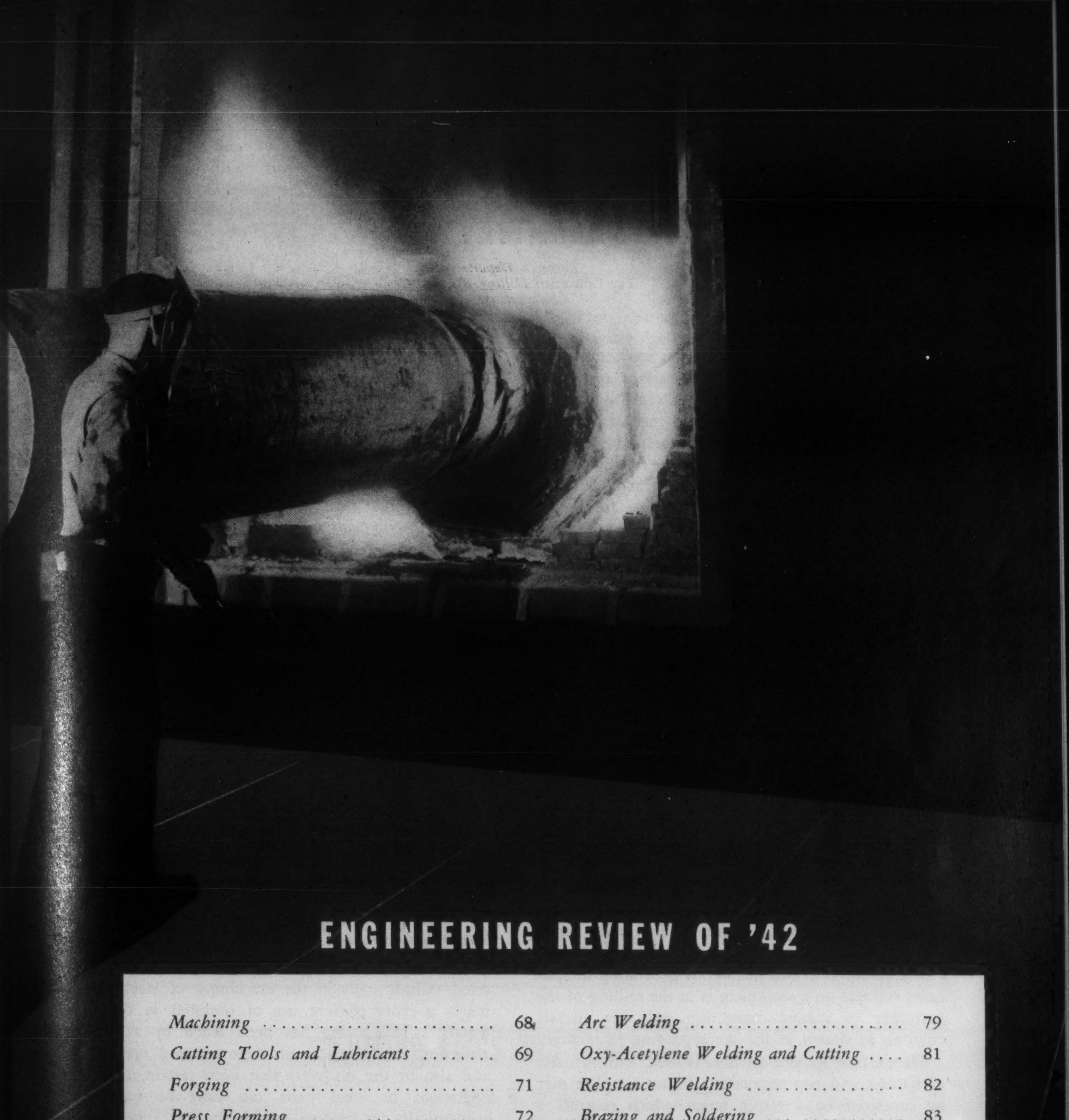
Tin Bronzes

One example of the whole situation is the tin bronze 88-10-2, 88 Cu, 10 Sn, and 2 per cent Zn. This alloy is in all the engineering handbooks and college textbooks. Lifted from these handbooks and textbooks, it is specified by hundreds of design engineers.

Specifications formerly required this alloy to be made from "virgin" metals, and the product to have less than 0.10 per cent Pb and less than 0.05 per cent Fe. Years ago, it was shown that substantially similar final properties resulted from the use of an alloy containing only 8 per cent Sn and 4 per cent Zn and now known as the 88-8-4 alloy. For certain heavy castings, this lower tin content alloy has advantages over the 88-10-2 variety. However, the 88-10-2 variety is insisted upon by many design engineers in spite of its higher tin content and higher cost with no compensating advantages.

Recently it has been shown that substantially equal final physical properties result for both of these alloys even when the lead content is increased to 0.50 per cent and the iron content to 0.25 per cent and no "virgin" or primary metals are used in making the alloy. With this increased lead content comes some improvement in machinability. Machinability has always been a problem with the 88-10-2 alloy.

Many "engineers" are still resisting changes in specifications to comply with this knowledge, to increase the availability of the castings which they desire and to improve quality at the same time.



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Machining

by Hans Ernst and M. E. Merchant

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Spurred by the need for maximum production from every available machine tool, the art of machining metals has undergone a material advance during the past year. The general trend of this advance has been greatly influenced by two factors, both associated with the war effort, namely, the relative shortage of skilled machinists, and the scarcity of tungsten — and lately of molybdenum — for use in tool materials.

More Automatic Machines

The first of these factors intensified the swing toward increased use of automatic machines for a wide variety of machining operations, and in an increasing number of industries. The continued growth in the use of automatic machines in the aircraft industry remained outstanding. In addition, this same factor contributed to the greater use of centralized machine grinding of cutting tools instead of hand grinding by the individual operators, and brought forth new, concise machinability rating charts, and helpful calculators, to aid in the selection of feeds and speeds for machining operations on various work material.

An interesting aspect of the increased use of automatic machines is seen in the advances made in the application of automatic profile milling, using sensitive tracer control from a master or template. One recent application of this method of generating complicated surfaces on a workpiece is in the milling of the periphery of master connecting rods for aircraft engines, as shown in the accompanying illustration.

Here a four spindle machine is used, with two sets of fixtures and two templates. Either template may be contacted by a tracer finger which controls a sensitive hydraulic valve that coordinates the two slide motions, thus duplicating the profile of the template. Four rods may be machined simultaneously in one fixture; meanwhile the operator unloads and reloads the other fixture. Thus very high, continuous production is maintained.

Tipped Cutting Tools

Many innovations and advances can be coupled with the scarcity of tungsten and molybdenum. Among these might be included the increasing use of tools tipped with high speed steel to replace solid high speed steel tools, and the greatly increased use of sintered carbide tipped tools for the machining of steel; also the increased emphasis on correct cutting tool design and fine tool finishes, the development of new surface treatments to increase the life of high speed steel cutting tools, and some progress in the development of radically different cutting fluids.

The use of cutting tools having tips only of high speed steel, which results in more efficient use of tungsten and molybdenum, has been aided by improved means for attaching such tips to suitable shanks. A method has been developed whereby previously hardened high speed steel tips may be brazed to low alloy steel shanks without affecting the hardness of the former. In another method, tips are cemented on with a metallic cement which is reported to give a bond stronger than the high speed steel itself.

Although the use of tipped high speed steel tools was at first considered a temporary measure only, born of necessity, it now appears that such tools may be superior to one-piece high speed steel tools, for certain applications. The tipped high speed steel tool may, therefore, remain an important member of the family of metal cutting implements.

Sintered Carbide Tools

The very noticeable swing during 1942 to sintered carbide tools in the machining of steel, also marks a more efficient use of tungsten in cutting metals. This swing has been aided by a sharp reduction in the prices of these sintered materials and also by the discovery that even certain milling operations on steel parts can now be handled economically by sintered carbide tools if a *negative* "true rake" angle be employed, generally in combination with high surface speeds and low values of feed per tooth. ("True rake," as distinguished from back rake or side rake, is measured in the plane of chip flow.) This combination has made possible the milling of very hard steels, at rates of production even higher than with high speed steel, and with marked improvement in finish. The work of developing this milling technique has been done partly at Watervliet Arsenal and partly in scattered applications elsewhere.

While the use of negative true rake angle, with high speed and low feed per tooth, extends the use of sintered carbide to difficult milling operations which can not otherwise be handled with this material, this combination usually results in a considerable increase in power for a given rate of metal removal.

Cutting Tool Design and Finish

The effect of cutting tool design and finish on tool life has been subjected to increased scrutiny during 1942. One widely discussed study in this field has shown the benefits to be derived from such a scrutiny. Applying the findings obtained from extensive shop tests, tools of standardized design were developed for use on rough turning operations. These tools were machine ground and honed to a fine finish (3-3.5 microinches r.m.s). As a result, tool life has been greatly increased — as much as 10 to 20 times in certain operations. This increase in tool life must not be attributed only to the fine tool finishes used, since the adoption of a proper, standardized tool design maintained by machine grinding undoubtedly may be an equally important, if not more important, factor.

Important advances have been made during 1942 in the field of surface treatment for prolonging the life of cutting tools. One of these is an improved method for the chromium plating of cutting tools, whereby a firmly bonded thin chromium plate is obtained. While considerable improvement in tool life has been reported from some applications, sufficient data have not yet been gathered from well authenticated and carefully controlled tests to indicate the probable extent of commercial application. Another advance in this field is an improved nitriding process for high speed steel cutting tools.

The field of cutting fluids has seen considerable activity during the past year. As regards theory, additional knowledge has been compiled concerning the fundamentals of cutting fluid action. As regards practice, several new and unusual fluids have made their appearance. One of the most unusual and interesting of these is a material which, up to a certain limiting cutting speed at least, provides an unusually effective cooling action, and which exhibits an apparent specific heat much greater than that of water itself, over a certain temperature range.

In the field of grinding, notable advances have been made in the application of the centerless method for grinding the external profile of shells and armor piercing cores; also draw punches for medium and small caliber cartridge cases. In the aircraft industry countless parts of complex form are now being ground on non-mating surfaces solely to improve their fatigue life by elimination of the "stress raisers," or scratches, left by previous machining methods.

The relatively new field of thread grinding has also seen advances in the past year, and the expansion in the use of this method of generating threads is notable. It is now being used extensively in routine production work and finds wide application in the aircraft industry.

Considering the many and significant advances in the machining of metals reviewed above, together with others which must remain secret during the war period, it appears that the present intensified interest in efficient machining of metals is already bearing its first fruits. These present a promise and a foretaste of far-reaching and revolutionary advances which we must expect to see, within the next few years, in the gradual development from the art to the science of metal cutting, with engineering principles playing an increasingly important part in practical machining operations.

Cutting Tools and Lubricants

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Because of the shortages of critical elements used in metal cutting tools, such as tungsten, chromium, vanadium, cobalt, molybdenum, and manganese, most of the high speed steels now being recommended by the War Production Board are of the tungsten-molybdenum type. At present 65 per cent being used are of the 5.50 W, 4.50 per cent Mo type; 20 per cent are of the 8.5 Mo and 1.5 per cent W; and 15 per cent are of the 8.5 Mo and 2 per cent V. It is understood that shortly 70 per cent used will consist of the 5.50 W, 4.5 per cent Mo types, and 30 per cent of the second and third types together.

To conserve these critical alloys the practice of using tools tipped with high speed steel or tool holders employing bits of the cutting tool material has grown rapidly during the year. The tips (small pre-formed pieces of the cutting tool material) may be attached to the shank of plain medium-carbon steel by clamps or by the use of a cement which melts at the hardening temperature of the tool material, or by the use of brazing solders that melt at about 1000 deg. F., which is lower than the tempering temperature of the tips. Tips of cast chromium-tungsten-cobalt alloys may also be welded to steel shanks. Cemented carbide tips are brazed.

The quantity of the critical materials of tool steels in these small tips is very small compared to that required in solid tools, even though the solid tools are used on mass production work. An example to show the economy of using tipped tools compares the cost of a solid high speed steel tool of 7/16 in. sq. size with that of a cemented carbide tipped tool shank of the same size. The cost of the latter tool as purchased completely ground and ready for use is only about 5/6 of the solid high speed steel tool as purchased, heat treated, but unground for use. For the proper application the productive output of the cemented carbide tipped tool exceeds that of the high speed steel tool.

The sizes of square and rectangular bits and tool shanks for high speed steel, cast metal, and tipped cemented carbide tools are now being standardized by the American Standards Association. This simplification will not only lead to lower costs in manufacturing the tools, but to better interchangeability. Except where breakage is a factor, a tool of small size will give the same productive output as one considerably larger.

Treating and Finishing of Tools

The cyaniding or nitriding of tools of high speed steel has been extended during the past year. It admittedly improves tool performance, particularly on relatively light or finishing cuts such as reaming, threading, and broaching. The chromium plating of high speed steel tools is being used with satisfactory results, although practice still indicates a widely varying degree of success of this practice. The most favorable results are being obtained when a thin plating is followed by a heat treatment of approximately 1 hr. at 350 deg. F.

The finish of tools is an important factor in their preparation for production. A method of producing fine finishes on tungsten high-speed steel and cast tungsten-chromium-cobalt metal cutters has resulted in increased production per re-grind of some 9 to 300 per cent. These tools were rough ground with a 60-grit aluminous vitrified wheel and then finished on a 320-grit silicon carbide shellac wheel.

A resinoid bond is now being used instead of the shellac. This work has only recently been published by the Norton Co. "Tool Life Increased 20 Times" is the title of a recent article on work done at the Wright Aeronautical Corp's. plant. The results described are believed possible because of the fine finish on the molybdenum high speed steel lathe tools used. A 220-grit aluminous vitrified wheel was employed for finishing the tool faces while the 320-grit silicon carbide shellac wheel was used to form the chip breaker. The high finishing or lapping of cemented carbide tools is of equal importance. Their effective cutting speed is greatly increased and their tool life is extended.

Particularly with the machining of steels of high hardness, high speeds are necessary in order to obtain the best machined surface. The high degree of finish makes this practice possible. Fine finishing of cemented carbides is done with 120 and 220-grit silicon carbide wheels or with 220 to 400-grit diamond wheels. The grit of diamond wheels should be finer than that of the aluminous oxide, because the diamond points become dulled more slowly.

Grinding marks from the wheel or hone should be parallel to the motion of the chips. A recent practice to improve tool performance is honing the face and flank of the cutting edge of the cemented carbide tool for turning cast iron, but when turning steel the cutting edge is honed to a slight champfer by means of a diagonal stick motion, to reduce chipping of the edge in service.

Recent trends are to use less back and less side rakes on cemented carbide tools, frequently carrying this to the point where both rakes are negative. For interrupted cuts excessive back rake, even up to 45 deg., is desirable as the shock on the tool at the beginning of each cut starts well back of the nose where the carbide tip is stronger.

Cutting Fluids and Speed

Cutting fluids may by proper application improve cutting speed for high speed steel and cast tungsten-chromium-cobalt tools up to 15 per cent. Their use on cemented carbide tools is somewhat doubtful inasmuch as the high speeds and off-coming chips cause the cutting fluid to be diverted intermittently from the tool so that the tool is subjected to frequent quenches. This frequently results in cracks and tool breakdown. Cutting fluids most generally used are of the emulsion type—that is, a soluble oil dissolved in from 10 to 40 parts of water, plain mineral oils, mineral oils plus fat and sulphurized oils. On most roughing work the emulsions are preferred if the machine tool will tolerate this liquid having less lubricating qualities.

Complicated machines such as automatic screw machines, gear cutters, etc., the sliding parts of which must be lubricated by the cutting fluid, have to use oils as cutting fluids. A mineral oil containing approximately 10 per cent lard oil is very satisfactory for general use. If possible, however, a plain sulphurized mineral oil should be used wherever an oil is needed, particularly in the case of slow cutting speeds as in threading, reaming, gear cutting, etc.

Sulphurized Oils

Sulphur base oils, which are fatty oils highly sulphurized, may be blended with various quantities of light mineral oil for use and in this way a mix may be obtained suitable to each job. The sulphur is essential, particularly on the slow machining of soft ductile metals. It will, however, stain copper and its alloys. Sulphur seems to react unfavorably with the cobalt binder of cemented carbide tools, and therefore is not recommended for this purpose.

Some of the newer oils contain chlorine. Chlorine is a lubricant and has proved beneficial in many applications, particularly where hard steels are being machined. Some mineral oils contain both chlorine and sulphur. In some plants where the steel chips are to be reclaimed after being machined with sulphurized oils, the sulphur is found to be carried through the furnace into the new steel so that in some of these plants sulphurized oils are not used extensively.

The improved practice of applying cutting fluids in large quantities at high velocity and at low temperature directly on the tool face is coming into more general use. Tremendous increases in production have been made during the year as a result of the application of better metal cutting practice.

Forging

by Raymond D. Moore

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Forgings for war or peace, from the mythical days of Thor and Vulcan down to our present extensive use of them, have always been produced in about the same way — using power, either manual or mechanical, to heat and pound metal into a form and texture that fit the needs of the moment. Recent contributions by engineers in the forging field have loomed large among the outstanding production accomplishments of American war industries.

Notable among these have been the development and use of larger and larger forging hammers, machines and presses for application to armament, aircraft and maritime production; improvements in the technical quality of aircraft drop forgings; the successful upset forging, on a high-production scale, of armor-piercing shot and high-explosive shell; the forging of Naval anchor chains; the solution of many complex heating and finishing problems in the production of large hammer forgings, etc.

Aircraft Drop Forgings

The aircraft industry, where safety and weight displacement are primary factors, has made especially heavy demands on drop forging engineers. There is a multiplicity of engine and frame parts that must be designed to extremely close tolerances, but must be made by fast-production methods and possess high strength when completed. They must have tensile and torsional strength to withstand the stresses of acrobatic maneuvers, they must be free of concealed defects, they must have reasonable machining costs and they must be produced with one eye on a subsequent heat treatment, now widely applied.

One of the outstanding features developed by the forging industry was the reduction of fatigue failures by elongating the grain structure. A most effective demonstration of grain flow control was accomplished in an airplane engine part called a cup gear, which had been previously machined from bar stock. The part, as produced from bar stock, when assembled in this engine and put to test, reached its fatigue failure in an hour, completely fracturing and destroying the other parts.

The airplane engineer confronted with this problem sought the assistance of the forging manufacturers, who designed this part as a forging so as to control the grain flow with respect to the radial design of the cup and the teeth on the cup. Since the adoption of this method to produce this part, production has run into the hundreds of thousands of pieces.

A very important development in 1942 was the successful manufacture on a production scale of forged aircraft engine cylinder heads in aluminum alloy — a switch from the traditional cast heads. The forged heads are stronger, and permit a 12-15 per cent increase in engine power output without increase in weight. Rejections have also been reduced by forging, as against casting.

Upset Forging of Shot and Shell

A very recent forging development of outstanding importance, from both the design and production viewpoints, is the manufacture of 37-mm. armor-piercing shot used in tank guns. The forging technique employed produces a superior projectile with a 30 per cent saving in material as compared with machined bar stock. The practice applied effectively reworks the steel to eliminate voids, and achieves a grain flow that converges at the nose in a hard, tough knot of high penetrating power. The forged shot are being heat treated by both induction and salt bath methods.

The forging of high-explosive shells, of course, is not new, a good description of the high-production advantages and metal-saving economies in forged shells of higher caliber having appeared in METALS AND ALLOYS for September, 1941. But the upset forging of 37-mm. shell was done on a large scale for the first time in recent months. It involved many complex design and production problems because of the shell's very thin wall and long, small-diameter hole; one successful practice (described in *The Iron Age,* Nov. 12, 1942) is based on making the dies and tool holder in one piece, designing the punches so that only a small part of the nose of each actually does the piercing, and carefully regulating the flow of lubricant over the dies and punches — among other factors.

Heavy Forging

Despite a forced trend in armament production *away* from the use of forging (to relieve the pressure on heavily overburdened hammers and presses), engineers concerned with ingot cogging, billet forging, the manufacture of heavy crankshafts, of forged armor, etc. were far from inactive. The load was lightened considerably by increased production of centrifugally cast cannon, of rolled heavy armor and of cast armor plate, but the remaining demands on the heavy forging shops continue to be enormous — both as to physical size and production volume. One real problem being faced and solved every month by some plant forging ingots or billets is the suddenly-developing inadequacy of stock-heating or finishing capacity as new hammers are installed or ingenious methods evolved to speed up the hammer ouput.

But all branches of the forging field stand ready and willing — in the present hour of trial and in the better days to come — to give of every ounce of power, every spark of ingenuity and every moment of time to make this world a better place in which to live.

Press Forming

by F. G. Schranz

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In the processing of metals so as to apply them to our wartime needs in structures, machine tools, appliances, etc., modern presses of various designs — some old, some improved, some radically new — have played a dominant part in forming and shaping both ferrous and non-ferrous metals to these special requirements.

Steel plates for ships, boilers, tanks, buildings, etc., are cut and bent to shape by various methods of flanging, bending, dishing, drawing, upsetting, spinning, forging, extruding, etc. These forming operations are performed in presses of either the hydraulically-operated or mechanically-operated type. Many different types of bending presses, flanging presses, stretching presses, upsetting presses, forging presses, extrusion presses, etc. are employed for this work.

General Forming Operations

Shipyards use hydraulic keel plate bending presses which have capacities from 500 tons to 3000 tons and form plates up to 3 in. thick, 30 ft. wide. A similar type bending press for forming the welded high pressure steam drums, cracking stills for oil refineries, hydro-pneumatic accumulator bottles, etc., has a capacity of 6000 tons pressure and will bend plates up to 8 in. thick and 40 ft. long.

Welded electric motor frames made from thick steel slabs are first crimped at the ends in a hydraulic crimping press and then rolled to circular shapes in powerful bending rolls. Horizontal, pyramid type, bending rolls are used in all shipyards, boiler and tank shops. The largest bending roll of the vertical type was used for bending the inlet pipes to the turbines at the Boulder Dam. This roll bent 14 ft. wide plates, 3 in. thick, to a 30 ft. diameter circle.

Flanging and forming presses for both hot and cold bending work are used wherever a steel, aluminum, brass or copper plate is formed into shape by means of dies. All aluminum shapes for airplanes are formed in hydraulic presses from 100 tons to 5000 tons capacity.

Locomotive boiler heads, firebox sheet, corrugated car ends, etc. are flanged or pressed in hydraulic presses up to 3000 tons capacity, having a working area or die space of 12 ft. by 15 ft. Most shipyards and pipe shops use hydraulic pipe bending machines, hydraulic gap bending and joggling presses, sectional flanging presses and forging presses.

Bending Armor Plate

The steel mills that furnish armor plates for combat tanks use 600 to 1200 ton hydraulic straightening presses; also, the steel foundries which make the cast armor turrets must straighten these castings on large gap-type 600-ton hydraulic straightening presses.

The powder metallurgy field uses powerful hydraulic presses for forming the shapes of various powdered metal composition such as gun parts, gears, tool bits, etc., which require a pressure of up to 100 tons per sq. in. on the powdered material when pressed into a die of required shape.

Other methods of forming metals are the spinning process for forming circular shapes as, for instance, the nose shape on bombs, lamp reflectors, etc.; also, large spinning machines with combination of hydraulic power and electric drive for forming large tank and boiler heads up to 18 ft. diameter, 1 in. thick steel plate, weighing 15,000 lbs.

The hydraulic extrusion presses in capacities from 500 to 6000 tons are, today, the most important equipment in the manufacture of aluminum, magnesium, bronze and copper shapes, such as used in aircraft construction, etc.

Baling Presses for Scrap

Hydraulic baling presses are used for forming loose steel sheet scrap and shapes into bales for remelting purposes. The loose scrap is charged into a steel baling box, for instance 60 x 24 x 18 in., and hydraulically-compressed into a bale measuring 18 x 10 x 17 in., weighing from 350 to 500 lbs. per bale.

Hydraulic briquetting machines for briquetting cast iron borings or steel turnings take the loose chips which are fed into the hopper of the briquetting machine and compress these chips into a briquette about 4 in. in diameter, 3 in. thick, which weighs about 85 per cent of the solid iron. These briquettes are then charged into the cupola with very little melting loss.

A 400-ton 6-ft. sectional flanging press. (Courtesy: Baldwin Locomotive Works)

Heat Treatment of Steel

by O. W. McMullan

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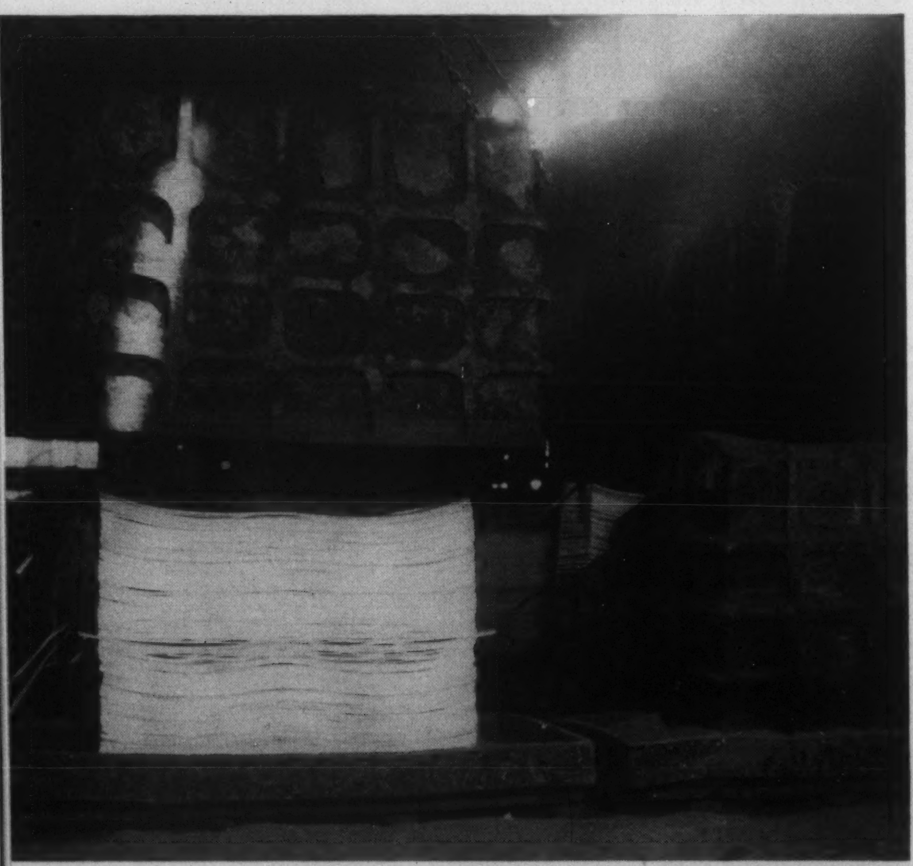
What might be termed the *art* of heat treatment of steel has lagged to a considerable extent behind the advance of the *science* of heat treatment, and also behind developments in the products to be treated. Progress in the steel industry during the past 10 to 15 years has brought about grain size control, closer control of composition, and general improvement in quality of steel produced. Economic pressure during depression years created demands by consumers for cheaper steels of lower alloy content and consequently of weaker hardening characteristics, especially as to depth hardness, and surface hardness also, of larger sections.



Containers for heat treating steel sheets. (Courtesy: Youngstown Sheet & Tube Co.)

While these changes necessitated certain changes in heat-treating procedure, such changes were mostly in the direction of more drastic quenching media such as water or solution rather than oil. While some companies did design special equipment and employed time quenching, for the most part few or no advances were made in the heat-treating art.

Effect of New Steels and Larger Parts

Added to the trend started by economic conditions is now the necessity brought about by the war, of reducing most alloying elements to an absolute minimum. This has created new incentives for experiments with special deoxidizers and addition or "needling" agents, a relatively recent development in the attempt to produce higher alloy steel characteristics in carbon or low alloy steels. These steels must be heat treated to bring out their inherent characteristics and thus we find old familiar compositions requiring new heat-treating procedures.

The war has brought about another change which adds to heat-treating problems. In the automotive industry, for example, it is not uncommon to find companies producing parts similar to those of peace times, but using three times the amount of steel for the same number of parts, that is, the parts on the average are three times as large. Much new production is in parts of large size also. In addition also are found higher hardness and higher physical property requirements than formerly specified for the smaller parts.

This is in contrast to normal tendencies and necessitates faster quenching rates and brings up problems of distortion, cracking, etc. It is imperative that the art of heat treating keep step with the science if satisfactory results are to be obtained. We do find that considerable progress has already been made in improving the old standard methods of heat treating used for so many years.

It may therefore be stated that demands on present day heat treatment require: (1) The treating of larger sections, frequently with high hardness requirements and not uncommonly with controlled depth of hardness; (2) high hardness and physical properties from shallow hardening steels of low alloy content; and (3) obtaining these properties in the desired portions of the finished part without undue distortion or cracking and without damage to surface layers. Some of the means of obtaining these ends are discussed below.

Deep hardening in large sections can be obtained only with higher alloy contents. Heating methods and quenching rates effect some control, and developments in this direction will be mentioned later.

Control of Hardened Zones

Several means may be used to control the depth and location of hardened zones frequently demanded in war production in various sizes and compositions of steel. This may be done either by heating or quenching procedures. The most common older method, and still used, is localized heating in molten baths. Cleaner, more rapid, better suited to surface hardening to a desired depth and fitting into continuous production lines is induction hardening. Flame hardening is another method for accomplishing similar results and may be especially suitable for large sizes and spot hardening irregular areas or shapes. All of these processes are discussed in detail in the article by R. J. Peters in this issue.

The surface heating methods just mentioned make faster quenching possible. Water quenching or even caustic or salt solutions may be necessary substitutes for oil quenching when alloy content is lowered. Group quenching must be eliminated for individual quenching.

Improved Quenching

Slow circulation of the quenching medium and hand agitation of the work has given way to submerged jet quenching, either large jet or multiple jet along the entire surface. Rotation or other movement of the work may be provided at the same time. Similar methods are used to obtain higher hardness or greater depth of hardness in the higher alloy steels. Time quenching may be used to control depth of hardness. A very recent development in the control of quenching oils is the production of fast quenching with cooling characteristics nearer to those of water than to the old type quenching oils.

Drastic quenching carries with it the danger of cracking or distorting the part quenched and leaving high internal stresses lowering load carrying capacity of highly hardened parts. Mechanical devices such as fixtures and press quenching, pressure rolls for shafts, etc. have long been employed to hold work to shape. Induction and flame hardening can eliminate distortion because of the relatively small volume heated compared to the amount of metal remaining cold. Likewise those methods reduce cracking because of the backing of soft tough metal. When heated throughout, time quenching and getting work into the draw furnace while hot are necessary to prevent cracking.

Even rather highly alloyed steels of medium or higher carbon can be water quenched by careful control. Continuous conveyor quenching of such steels is being used where the work is gradually removed from the water and the heat from the softer portion first removed serves as a draw for the highly hardened zone last to rise from the water or solution. Such a procedure provides zone and depth control of hardness as well as elimination of cracking. The use of the new oils mentioned in one of the preceding paragraphs may provide desirable cooling rates for a particular size, design and steel composition that will minimize distortion and cracking.

Austempering in sizes and suitable compositions accomplishes the same results, reduces internal stresses and provides superior properties. Another suggestion to reduce internal stresses, cracking and distortion, is to hot quench (such as in molten salts) at a temperature just above that of martensitic formation, and then cool slowly so that the martensite will be formed in all sections, large and small, at approximately the same time thus reducing gradients in volume change and consequently induced stresses.

Shallow hardening steels demand minimum amounts of surface decarburization in order that the thickness of the already shallow zone be not further reduced in the most highly stressed portion. This necessitates machining to, or close to, finished size before heat treating. Controlled atmospheres are therefore increasing in favor for heating for quenching, also in annealing operations for surfaces not to be machined. Elimination of scale and its insulating effect increases cooling rates in the quench and gives better hardness; also cleaning costs are reduced. Similar results are accomplished by bath heating or quick heating methods such as induction or flame heating.

Surface Hardening

by R. J. Peters

Chief Metallurgist, Warner Gear Div., Borg-Warner Corp., Muncie, Ind.

The value of steel in many critical applications depends upon its surface. Regardless of the inherent quality of the metal, whether it be a lowly carbon steel or an aristocratic alloy, there is little difference if the surface is not properly prepared.

Beauty is only skin deep, they say. Be that as it may, a bearing, gear, or cam shaft would be quite "unbecoming" without a good "facial" treatment.

Before reviewing the most recent progress in surface hardening, it might be of interest to trace briefly the progress it had made over a period of *centuries* before this. Probably the earliest evidence of surface hardness was noted when iron was heated in a coal fire. It was endowed with hardenability and became much more useful.

The process of case hardening was known as early as 1540. Mild iron was immersed in molten cast iron and the absorbed carbon produced a hardenable surface. We owe the scientific development of case hardening to Reaumur, who disclosed his investigations in 1720. English operators introduced wood charcoal as a carburizing agent a short time later.

Gas carburizing was conceived as early as 1825, using illuminating gas made from organic compounds. Inability to produce gas tight durable equipment delayed its adoption.

The salt bath as a carburizing medium was not introduced until after 1900 and nitriding came along a mere 20 years ago.

Induction heating as a surface treatment has only recently become widely adopted, although induction melting has been in use many years.

Thus we see many of the familiar processes now in common use were conceived almost 500 years ago. Some basic applications and methods are still essentially the same after 200 years.

Gas Carburizing and Nitriding

Recent developments in carburizing still favor a wider application of gas in continuous operations. A notable improvement in gas preparation equipment has made available a dry stable gas, free from sooting and adaptable to case quality control. Catalytic cracking of methane, propane or mixed gases is carried out in a highly automatic generator. Alloy life has been doubled and furnace maintenance vastly reduced.

Gas atmospheres combining ammonia and hydrocarbons produce cases high in nitrogen, providing an alternative to cyanide for light case requirements. This type of gas can be used in standard carburizers to treat through hardening steels.

Developments in nitriding have improved the speed and quality. This has been accomplished to a large extent by better equipment and more efficient design. Low distortion makes nitriding essential where grinding or lapping after treatment is impractical. The low frictional coefficient of the hard case is an advantage in substituting for non-ferrous alloys in certain bearing applications.

The trend in solid carburizers seems to be in favor of non-burning compounds. Long life, cleanliness and rapid carburizing action characterizes these compounds.

Carburizing in Salt Baths

Salt baths for carburizing have not undergone any radical changes. They are becoming more definitely divided into light case (0.002 to 0.008 in. depth), medium case (0.010 to 0.030 in. depth) and heavy case (0.035 to 0.070 in. or more) types.

Flame hardening turret rings. (Courtesy: Linde Air Products Co.)

Deep case baths are receiving attention at present. They afford fast action and produce cases quite comparable to conventional pack or gas carburizing.

Because of the high temperatures involved, internal electrode heating is preferable. This method of heating promotes uniformity and conserves pot life.

Rapid Advance of Induction

The rise of induction heat treating has been spectacular. Although not new, the rapid development of equipment has made this method mandatory in many applications.

We now have a choice of equipment offering considerable flexibility and improved efficiency. For applications requiring deep hardening on heavier sections, motor generator equipment will permit as much as 1000 kw output and 2000 to 30,000 cycles. Small units employing a spark gap oscillator provide frequencies up to 100,000 cycles at 30 kw. The vacuum tube converter type allows 50 kw output and frequencies up to 1,000,000 cycles. For rapid heating and "throwing power" over irregular surfaces, high frequencies and lower power are preferable.

For use on a variety of small parts, the spark gap equipment is effective. Coils may be built to fit special sections and the oscillator can be adjusted to compensate for wear, thus keeping efficiency at a maximum.

Flame Hardening

The open flame as a means of heat treating has been in use for many years. Hardening valve tips, cams and large gear teeth are familiar applications of this method.

The advantages of flame hardening consist of rapid scale-free heating and lack of distortion common to total immersion or furnace treatments. Large parts such as heavy pitch gear teeth, large cams and parts requiring localized hardening could not be as effectively treated by any other method, except possibly by induction.

Obviously, improvements in flame hardening have been largely confined to technique and equipment. Ingenious and specialized methods of indexing, quenching and directing of the flame are being devised daily. An advanced type of radiant gas burner has made possible an economical source of heat, and should further encourage the application of flame hardening.

Other surface treatments such as hard facing and a recent application of hard plating have contributed effectively to the salvaging of materials and tools, but do not depend upon the inherent properties of the basic metal.

Heat Treatment of Non-Ferrous Alloys

by A. S. Henderson and B. W. Gonser

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As a result of the present war effort, developments in the heat treatment of non-ferrous metals have consisted principally in the application of knowledge gained in peace time to the production of war materials. Because of the phenomenal progress made in this direction, the heat-treating field has reason to be thankful for its foresight in research and development. Without such a backlog of knowledge, production of war materials would suffer.

Salt Baths

In recent years, the use of molten salt heating furnaces has forged ahead in the non-ferrous field, as in the heat treating of ferrous articles. By using this type of furnace, it has been possible in many instances to insert the compact salt bath equipment directly into the machine line and thus eliminate a separate heat-treating department. When this procedure is used, a number of handling operations are eliminated and it is possible to keep the inventory at a minimum.

The application of the molten salt bath in the solution treatment of aluminum alloy rivets is of particular interest. Because of corrosion and other factors, the rivets can not be economically heated in direct contact with the molten salt; therefore, the rivets have been treated in alloy cylinders which act as small furnace muffles. The cylinders are then heated by direct contact with the molten salt. By the use of several cylinders on a rotating beam, the procedure can be made semi-automatic.

Large sheet sections of aluminum alloys have also been solution treated in salt bath furnaces, and, according to the manufacturer's claims, have several advantages; notably, individual treatment, speed of operation, and distortion control.

Use of Protective Atmospheres

Through consistent research on furnace atmospheres, protective atmosphere furnaces have progressed to the point where a tailor-made atmosphere can be produced for many applications. By proper furnace control, many copper and brass articles can be brightly annealed in a furnace atmosphere of the products of combustion of the heating gas. Sulphur compounds in the gas continue to give considerable concern, but if proper precautions are taken, the difficulty can be overcome.

Protective atmospheres have been employed in many of the large scale continuous heating furnaces and excellent results have been obtained. By the use of specially designed burners, it has been possible to improve the entrance and exit ports of the continuous furnace. Handling equipment has also been improved to speed production. Thus, a recently constructed radiant tube heat-treating furnace quenches 4 tons of aluminum or magnesium alloys in 25 seconds by means of an elevator cage.

Because of the large number of publications on the use and production of protective atmospheres, the average heat treater has been made atmosphere conscious. This condition has helped in overcoming the natural reluctance in accepting these furnaces by the production men and thereby changed their status from that of special equipment to that of general use.

As a result of war work and the increased interest in heat treating non-ferrous metals, the quenching bath has been investigated. Through the use of soluble oils it has been possible to obtain a variety of cooling rates suited to the type of work.

Although refrigeration has seldom been considered a heat treatment, its usefulness in arresting changes, such as age hardening, deserves mention. At the recent Metal Show a considerable amount of space was devoted to the display of mechanical refrigeration equipment. By providing adequate storage facilities, solution treating of rivets can be conveniently scheduled and thereby save both equipment, time, and labor.

Heating Furnaces and Refractories

by M. H. Mawhinney

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The industrial furnace designers and engineers have carried a heavy load in the emergency re-tooling of industry. This concentrated effort during the past year has not encouraged a great deal of new invention in the furnace field, but the emergency has caused applications of existing designs to uses which were not considered in conservative peace times, so that the advances are similar to those resulting from new invention.

Two outstanding causes of expansion in the heating field are the annealing of steel at the mills and the manufacture of munitions.

Annealing and Atmospheres

The tremendous expansion required in annealing capacity has caused the installation of thousands of furnaces of the usual car and pit types for the annealing of steel in the form of ingots, castings, billets, and bars, and little comment on these types is necessary. The requirements for the annealing of rods and wire in coils and of flat and coiled sheets and strip have promoted the use of circular and rectangular hood furnaces in many forms, which is important because the use of retorts and protective gas generators has also been advanced rapidly.

The result will be that the use and technique in applying these atmospheres after the war will be far ahead of where it would have been without the emergency. The efficiency of steel manufacture will benefit from the improvement in control of oxidation and decarburization which is possible with these gases.

Munitions Heat Treatment

In the manufacture of munitions, including shells, shot, bombs, and guns, an interesting furnace question is the choice between fully automatic and less efficient equipment, particularly for the heat-treating operations following forging. Here the furnace designer faces the critical man-power shortage on the one hand, and on the other, he is confronted with the almost daily changes in munitions which have been characteristic of this war to date.

A number of fully automatic furnace installations have required almost immediate rebuilding to suit changes in specifications of the heat-treated product. The better choice seems to be the semi-automatic equipment which can be quickly and cheaply adapted to changed specifications. Examples of semi-automatic furnaces include rotary hearths with external handling equipment, car type furnaces with rapid handling devices and motor driven cars, and pusher furnaces with trays or carriers and external handling facilities for unloading and quenching.

In any of these types the advantage is in a wide range of flexibility and a minimum of nickel-chromium alloys in most cases. The only disadvantage is in the relatively small increase in labor required over fully automatic furnaces.

In the forging operations, rotary hearth furnaces have been more widely adopted and the induction method of electric heating has become popular for munitions forging, where a large number of identical pieces are to be heated. This method produces a rapid and accurate heating without scale but is open to the objection of lack of flexibility to meet changes in specifications.

Refractories and Fuels

In the field of furnace refractories, no outstanding improvements are known to the writer, but the use of light refractories has increased by leaps and bounds. The effect of the wider use of these light firebricks will be a very considerable fuel saving to the nation.

The distribution of fuels to war-time expansion has presented some very interesting problems to the furnace engineer. Because of limitation on the use of gas he has been forced in some localities to apply fuel oil to furnaces previously considered very undesirable for fuel oil application. In many cases where care has been taken in the selection of burner equipment for burning the oil in small quantities, surprisingly good results have been obtained. Another effect of fuel limitations has been the installation of producers for anthracite producer gas, which fuel is being burned with cold air in billet heating furnaces up to 2400 deg. F. with no loss in production or quality of heating. New coke ovens have provided additional fuel to industry, and experiments are reported on the combustion of liquid gasoline for industrial furnaces.

In conclusion, it is probable that the war years, although not marked by outstanding invention in furnace design, will be the source of invaluable data on new methods of using existing designs.

Welding a gas producer shell. (Courtesy: Lincoln Electric Co.)

Arc Welding

by S. L. Hoyt

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The year 1942 witnessed another upsurge of welding that not only vastly speeded up our war production, but also brought this relatively new craft forcibly to the attention of the country. Over the radio we heard: "She's a welder out at Lockheed"; and in a cartoon we read, from a child to her mother: "But I don't want a doll; I want a welding set." Possibly such quips tell the most important story of welding in 1942.

In 1941, the last year for which statistics are available, the production of weld rods was over 450,000,000 lbs., or up 90 per cent over 1940. Ten years ago, the weld rod production was 2.6 lbs. per ton of steel produced and in 1939 and 1940 this figure had increased to about 5 lbs. per ton. In 1941 it was 7 lbs. per ton, which shows a striking increase in the use of welding in fabrication. This increase was due principally to the expansion in our shipbuilding and ordnance programs.

In passing we may note that the sabotaged Italian ships were repaired in about one-fifth the time thought by the enemy to be possible, thanks to the high state of development of the art of welding.

In Shipbuilding

In ship production, welding has been used not alone as a simple substitute for riveting, but it has made it possible to streamline the whole process and reduce the time in the yards to a minimum. The outstanding achievement was that of Mr. Kaiser who was able to launch a ship only 10 days after its keel was laid. Since then, the time has been cut about in half.

In the past, there has been some doubt expressed as to the reliability of welded fabrication due to stresses which seem invariably to be locked up in a ship structure. There has been considerable work done on this point, but those fears are now known to be unfounded since there are many welded ships in successful operation at sea. Of course these studies will continue and there can be little doubt that lighter and safer ships will be produced in the future. In this connection the use of gas cutting and the continuous Unionmelt process have played vital roles in this field.

A similar advance for bridge and outdoor construction cannot as yet be recorded. According to one authority, the principal reason is inadequate design. To meet this situation, Mr. Horton proposed a special design for a welded bridge which received favorable discussion. In the meantime, a bridge of the Florida East Coast Railroad and another one in Tasmania were erected by welding and have been described. In the background, a large amount of testing is under way and great attention is being given to welding technique and other details.

The situation with railroad locomotives has not changed much in the past year. The experimental locomotive on the Delaware and Hudson has been in service four years and is reported to be satisfactory. Welding the firebox is now permitted due to the new code and good weld rods. The railroads are anxious to have a free hand and by welding feel they will secure relief from intergranular cracking.

In Building Aircraft

In aircraft manufacture and repair, welding continues to play a dominant role, particularly arc and gas welding the frames, etc. Still in flux are equipment and electrodes and the question of DC vs. AC. More experience has been gained with crater eliminators and methods of controlling the arc, but to date the design and manipulation have not been all that is desired.

Flash welding has continued to develop and appears to be highly satisfactory for steel. Considerable research is still going on in arc, flash, and spot welding and pressure gas welding. In the shop, qualification of welders, inspection, and procedure control have been highly perfected by those responsible for production welding, aided by the Army and Navy. It is very likely that the change from SAE 4130 to the alternate chromium-nickel-molybdenum steel will be made without discomfort.

Atomic Hydrogen Welding and Other Wartime Aids

Atomic-hydrogen arc welding has found many new devotees during the year. Its advantages of very rapid heat transfer into the work, plus the fact that no flux is needed on many jobs, have recommended it for many of today's special war production problems—for repairing and fabricating "difficult" mold and die steels, welding aluminum alloys, light gage parts and other jobs that are often difficult or impossible to handle by other methods.

Welding has also made continued progress in ordnance and ordnance equipment. Here, as in aircraft welding, the difficulties are magnified by the necessity of welding high strength steels. Advances in this art entail a vast amount of labor in research, testing, etc. and in drafting codes and specifications. This work centers in the activities of the American Welding Society, the Welding Research Committee, the N.A.C.A. and other Government bodies, and more recently the War Metallurgy Committee. The work being done today on joint design, weld rods, stress analysis, testing, inspection, steel quality and "weldability" is vital to improving the practice of tomorrow.

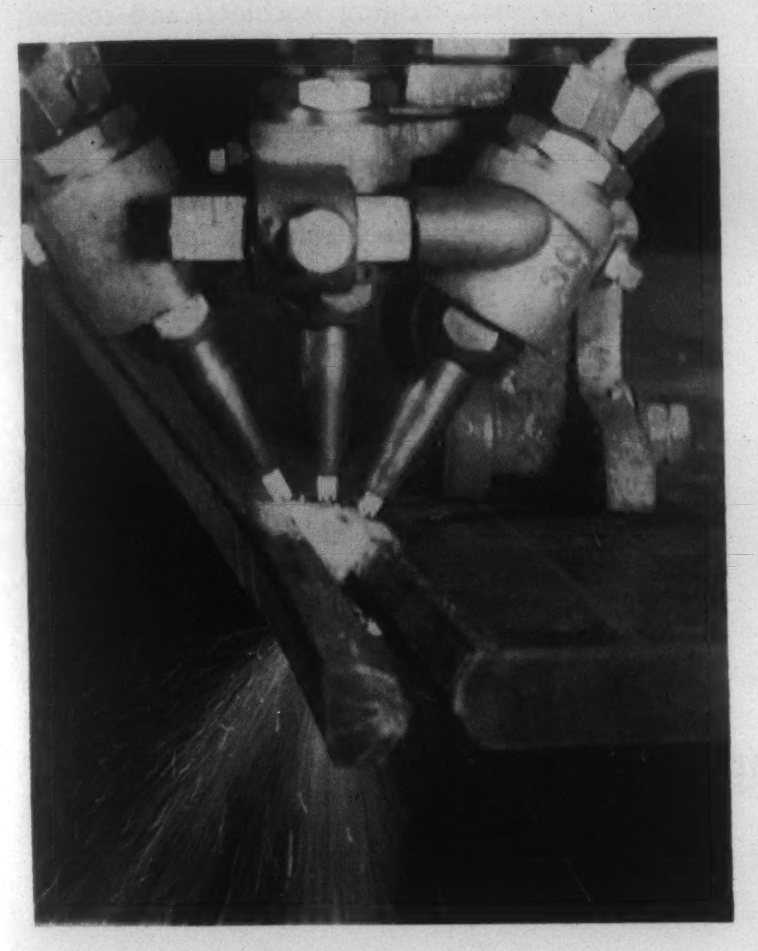
A more immediate application is the study being given to more economical use of electrodes. It is proposed to do this by modification of design, the use of larger electrodes, improving the efficiency of deposition and by reducing the stub end loss. The latter represents a wastage of over 15 per cent. In the interests of better current economy, also economy in materials that go into the making of the machine itself, the use of alternating current arc welding is being more vigorously advocated. Not only have equipment manufacturers contributed substantially, but the availability of the new Grade E-6011, all position, electrode has materially extended the possibilities.

In this review, no particular effort has been made to point out all the new developments. A very novel method which should be mentioned is the "Heliarc" method of welding magnesium, aluminum, and other materials in an atmosphere of helium. Another interesting development is a new cast iron weld rod described for the first time at the recent meeting of the American Welding Society. It appears that this rod takes us into a new field of gray iron metallurgy in which the various elements seem to behave in quite an unpredictable fashion. The result, however, is a soft gray deposit of weld metal. Detection of cracks in non-magnetic metals appears to be materially improved by "Zyglo" which has just been introduced for fluorescent inspection.

Oxy-Acetylene Welding and Cutting

by A. K. Seeman

The Linde Air Products Co., New York



Cutting a double bevel on heavy steel plate. (Courtesy: Linde Air Products Co.)

The past year has witnessed not only a phenomenal increase in the use of conventional oxy-acetylene welding, cutting, and heating applications but also the successful introduction of new ones. Naturally the necessities of armament production schedules stimulated the development of new processes and techniques which, in review, disclose unique and important contributions to the "Arsenal of Democracy." In point of importance, no one application eclipses any other and the following random selections, therefore, indicate the versatility of the process and, it is hoped, suggest solutions of other wartime production problems.

Cutting Operations

Oxy-acetylene cutting is of major importance, and special machines have been developed for the shaping of steel for ships, tanks, and other war material. The technique of simultaneous cutting and beveling has been perfected so that assembly welding can be performed without intermediate machining operations. Armor plate and other sensitive air-hardening steels can be flame-cut and the cut surfaces immediately flame-softened to avoid cracking or to obtain a machinable hardness. This technique has released heat-treating furnace equipment for other purposes.

Steel mills have been hard pressed to produce the huge quantities of plate and shapes necessary to the war program. The relief of this situation has been helped by the use of the oxy-acetylene cutting process to replace or supplement mechanical shearing operations on hot or cold steel. During the year improved cutting nozzles have been introduced which are not only more economical in their consumption of oxygen, but also produce close-tolerance cuts.

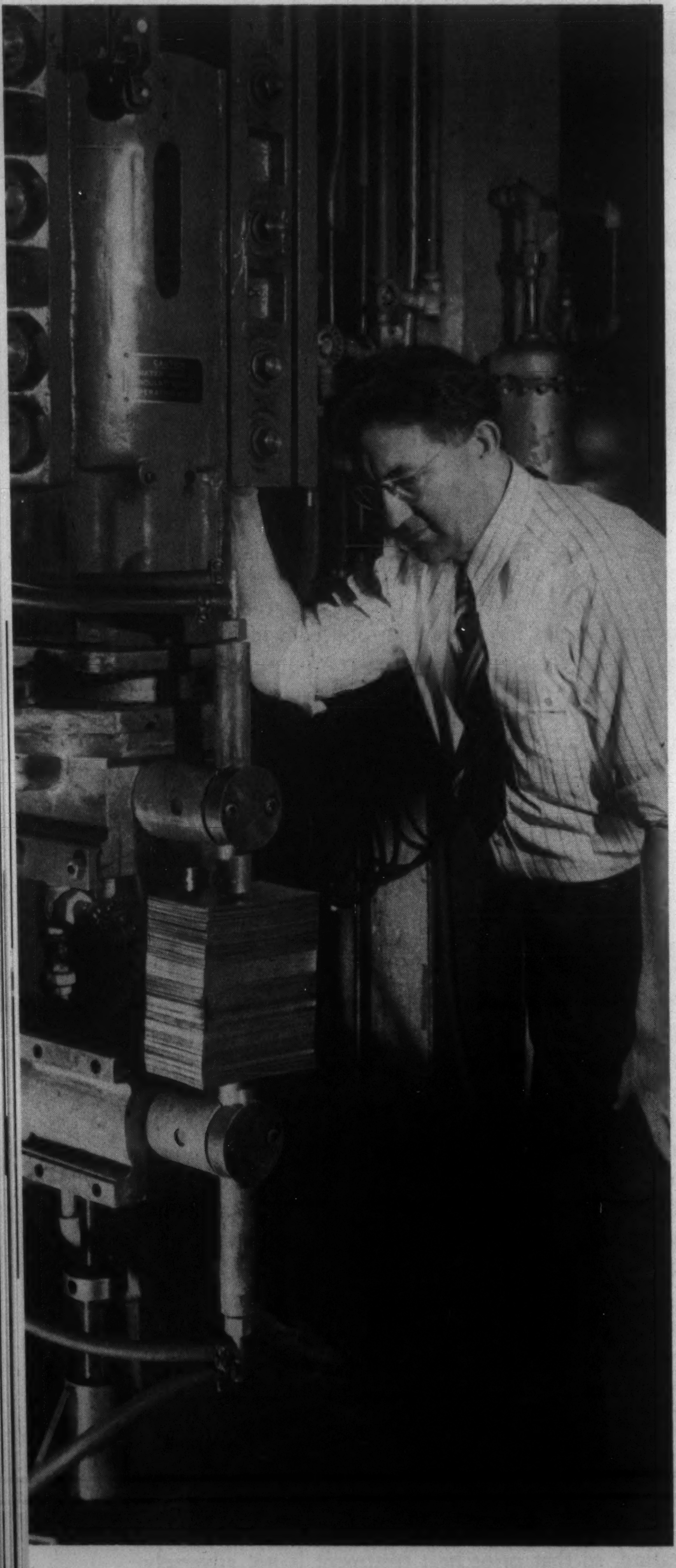
The past year has witnessed an expanding use of the oxy-acetylene process for the conditioning of steel. This method of surface-defect removal, with its speed and savings, is a major contribution to steel manufacture and has released heavy machine-tool manufacturing facilities for other important war purposes.

Welding

Oxy-acetylene welding applications are also important in increasing wartime production. Mechanical welding is applied to the production of high-grade steel tubing as well as the assembly of naval shell cases and incendiary bomb containers. Of timely importance is the mechanization of aluminum welding. An elaborate research program proved the practicability of this application which is a manufacturing procedure for aluminum shell cases and auxiliary gasoline tanks.

A number of articles are formed by hot-spinning, using the oxy-acetylene flame as a high temperature local heat source. This unusual application is employed to manufacture aerial bombs and other cylindrical articles.

The oxy-acetylene flame finds application in the assembly of a vast number of military articles that specify bronze-welding or silver-soldering. The flame meets the need for rapid heating and for localized heating, so that prior heat treatment is not adversely affected. Such applications are usually completely automatic and include shell-nose sealing and the assembly of chemical and incendiary bombs, and box-cover fasteners.



Pulsation resistance welding enabled the temperature to be equalized across 199 plates of 1/32-in. low carbon steel making a satisfactory weld. (Courtesy: General Electric Co.)

Resistance Welding

by R. T. Gillette

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The development and application of resistance welding processes, welding machines, and controls, has made very rapid strides in the last two or three years.

In developing various processes and techniques for resistance welding, it has been generally recognized that accurate control of all factors involved is essential if a high-quality product with a low percentage of rejects is to be expected.

With this in mind, equipment has been designed and built which is outstanding when compared with earlier equipment. To reduce inertia and friction on spot welding heads so that they can follow up the weld as heat is applied to soften the metal, various types of airlock heads have been developed. In these, the air lock is as near as possible to the welding point and the various parts of the head are equipped with anti-friction bearings.

This, in conjunction with variable pressure devices using the air control or double-spring and cam arrangement, results in welding machines that will follow up and give the proper squeezing action in the high-speed welding of many alloys of short temperature welding range.

New Electrode Systems

There has been a consistent advance in the development of new alloy electrode materials combining hardness or high compressive strength with high conductivity. With this, the development of improved cooling by getting the cooling medium as close to the surface to be cooled as possible and the use of various refrigerated electrodes have increased the life of electrodes. These have also decreased the so-called electrode pick up when aluminum, plated materials, and some of the low-melting non-ferrous alloys are welded.

The use of pulsation welding, whereby current is applied intermittently a few cycles "on" and a few cycles "off," has been of considerable assistance in welding heavy plate and for many special jobs.

The advance in different types of control equipment, particularly the fully synchronous electronic type, has kept pace with other developments. Completely automatic controls are now available to take care of preheat, weld, and post-heat programs with accurate time intervals for each. Such controls can be combined with the use of the pulsation welding method which may be employed for all or any part of a program control.

Attention has again been given to the welding and post heating or heat treating of many of the steels and alloys which are susceptible to heat treatment or hardening or which have other heat treatable characteristics. This saves a tremendous amount of time over post-heat treatment in a furnace or by other methods. This field for resistance welding now has great possibilities and volume since many devices, particularly in the war program, are being built of high-strength alloys to make them stronger and to reduce weight.

The use of the new resistance welding machines and controls has made possible the welding of aluminum and its various alloys, magnesium, etc., on parts which are subjected to stress and vibration, where welds made with the less accurate and consistent equipment of a few years ago were sometimes questionable.

Perhaps a few words should be said about cleaning. There are many advances, mechanical and chemical, being made in cleaning materials for welding. Full advantage must be taken of these to obtain a properly cleaned surface for welding; no equipment can consistently produce good welds on dirty or scaly material.

It would seem significant that with the equipment now available, the use of resistance welding should increase very rapidly. Some of the old stock excuses for not using resistance welding, such as lack of flexibility of equipment, inconsistent welding due to lack of adequate control, poorly designed and built equipment, lack of confidence, etc., are eliminated by the equipment now available.

Fabricating Special Alloys

One of the things needed now is an educational program to acquaint industry generally with the possibilities of fabricating by resistance welding various products from aluminum, magnesium, low and high-alloy steels, and most of the available special-purpose alloys, keeping in mind that many dissimilar combinations of metals and alloys may be successfully welded.

With the increased production of aluminum and various alloys and the availability of satisfactory resistance welding equipment, it seems logical that the post-war period should see a tremendous expansion in the fabrication of light-weight, high-strength equipment of all types.

Brazing and Soldering

by R. N. Chapin

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The persistent effort by all phases of industry during the past year to speed up production has resulted in several interesting developments in the field of brazing. This term is used here in its larger sense — the joining of two metal parts with a non-ferrous filler alloy or metal whose melting point is at least 1000 deg. F. and is lower than that of the parts being joined. This process is often called "bronze welding," "hard soldering" or "silver soldering." However, use of these terms is rapidly diminishing as they are not truly descriptive of the process.

The principal developments or changes that have come about are: (1) The rapid growth in the use of low temperature alloys because of their adaptability to speeding up production; (2) The development of rapid heating procedures either with multi-flame oxyacetylene tips or electric induction heating; (3) The return to cast iron welding on many repair jobs because of the high priority required to procure the high zinc bronze rods.

Low Temperature Brazing Alloys

During the past five years there has been rapidly increasing use of the group of brazing alloys that flow at 200-500 deg. F. lower than the high zinc bronzes in general use. Of this group, those most commonly employed are several of the lower melting point silver alloys (silver solders). There is also a copper-phosphorus alloy that is well suited for use on copper and copper base alloys. These brazing alloys can be used for joining practically all ferrous and non-ferrous metals and alloys except those having lower melting points. They are particularly free flowing and will penetrate deeply into the joints at their flowing temperatures, which vary from 1175 to 1325 deg. F. They produce strong joints capable of withstanding severe shocks and vibration.

Unlike gas or arc welding, the fluidity of these alloys eliminates the necessity to bevel the joint surfaces to insure proper penetration. If the surfaces are clean of oil and dirt and are well fluxed, the brazing alloys in this group will penetrate readily between joint surfaces having a separation of 0.002 to 0.010 in. when the parts are uniformly heated to slightly above the flowing temperature of the alloy.

In many instances, design of ordnance and armament parts has taken into consideration the high strength and production convenience of this group of alloys. Since these can be obtained in wire, rod and strip form of almost any gage, as well as washers, rings and special shapes, the parts to be brazed can be assembled with the brazing alloy preplaced in a groove or slot so that there is positive control of the amount of material in the joint. Where possible, this method is preferred to hand feeding.

The high speed of the assembly line up to the point where the brazing operation takes place must be maintained. Until recently, the oxacetylene flame and the furnace, which usually has a hydrogen atmosphere, were the customary methods of applying heat to the parts. However, the necessity to make joints two, five or even ten times faster than heretofore has led to the development of special heating equipment.

For example, oxacetylene tips are now made with multiple orifices so arranged that heat is applied to the parts in such a manner that little or no movement of the tip and torch is necessary. These odd looking but very effective tips become an integral part of the related equipment on the assembly line, and material flows past the brazing station or stations at the necessary production rate.

The so-called "low temperature welding" process for the rapid production of strong joints by methods akin to brazing, using a series of joint metals specially designed for each material being joined, has expanded in application to both production and repair work.

High frequency electric induction heating is also being used on many brazing operations where very rapid heating is required. On repetitive operations this method permits close control of temperature, which is often necessary to limit the annealing action adjacent to the joint on heat-treated parts.

High-Zinc Bronzes

From the above description of the newer low temperature brazing alloys we do not mean to imply that use of the high zinc bronzes has decreased. On the contrary, there has been a great increase in the volume of bronze rod used during the past year.

Brazing is too often considered as essentially a repair process. Every factory, large and small, and even the small village job welding shop has used bronze rods on many different kinds of metals. They are used to repair the smallest guide or bobbin in the textile mill and the mammoth housings of steel rolling mills. Inasmuch as it is practically impossible to purchase new machinery or even spare parts in many cases, the brazing process is indispensable for repairing broken equipment which must be kept operating at top speed.

Production brazing operations consume tremendous quantities of bronze. This has been particularly true for the past several years when the requirements for armament and ordnance have eclipsed normal domestic demands. While there are not as many specific brazing operations on production as compared with repair work, a surprising percentage of the total rod consumption during the year was used on these repetitive applications. It is indeed fortunate that the most commonly used silver brazing alloy has but approximately 15 per cent Cu content. This has simplified procurement under the priority regulations. Silver supply is not unlimited, but there appears to be enough to meet the brazing alloy needs of our tremendous war building program.

Effect of Priorities

During recent months an interesting trend away from brazing on repair work has been brought about by the priority situation. The high zinc bronzes with their high copper content (45-95%) require high ratings because copper is on the critical materials list. This has forced a change to cast iron welding on many jobs involving cast iron parts that would normally be brazed. Since cast iron can be procured on very low ratings many repair shops have reverted to the older cast iron welding process. Unfortunately, this requires higher and more careful preheating with subsequent slower cooling. The time required for making repairs is increased considerably in many cases.

As is the case with many other industrial processes, brazing has benefited materially because of the enforced requirements of the past year. Stronger joints had to be made faster with the result that alloys flowing at lower temperatures were used with faster heating methods. Considerable copper was saved by substituting silver in the brazing medium. The net result is that the brazing process has met the demands of increased production and has profited a great deal thereby.

Soldering

The major developments in the field of soldering stem from restrictions in the amount of tin that can be used in solders. Tin-free solders of the lead-silver type are rapidly growing in use, and although they involve higher working temperatures their use has introduced few difficulties not removable by minor changes in technique and equipment. Increasing in popularity also are lead-tin-silver-bismuth solders in which the tin can be held to 10-30 per cent with little practical difference in properties as compared to standard high-tin solders.

The Government and industry have made great strides in saving tin in solders and in learning how to use the "substitute" solders, but much still remains to be done.

Plating and Finishing

by R. M. Burns

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The metal finishing field has had the difficult task of meeting the stupendous requirements of war production in the face of serious materials shortages. The problem has lent impetus to developments which will have post war importance. The curtailment in manufacture of civilian products has diverted a large volume of finishing materials to war purposes, but the additional requirements of the war program have increased overall consumption in 1942 to a volume substantially greater than that of any previous year.

New Tinplates and Substitutes

The acute shortage of tin has imposed the most serious problem in the finishing industry and has made imperative a reduction in tin coating for cans from 1.50 to 0.5 lbs. per base box. This is being accomplished by conversion from hot-dipping to electroplating of strip stock. Both acid-sulphate and alkaline stannate plating baths are employed in the expanding commercial production. It has been reported that the use of potassium stannate has definite advantages over the sodium salt in the alkaline process.

Solder coated steel or terne plate is being employed in many instances as a replacement for tinplate. A further savings in tin of considerable magnitude has resulted from the use directly on black iron of an improved thin phosphate coating finished with lacquer or synthetic enamel. This coating will withstand the drawing, bending and crimping operations necessary in can manufacture.

Zinc Coatings and Replacements

Phosphating has long been used as a corrosion inhibitive basis for the anchorage of paints on steel surfaces. Its application to zinc coated steel sheets followed by painting has made possible a marked reduction in the thickness of the zinc layer. Wider use has been made of phosphated and black oxide coated steel, oil treated preferably with the so-called water soluble oils.

Zinc coatings in tropical interior exposures involving frequent dew-condensation are subject to "white-bloom." This formation of bulky white corrosion products is prevented by the use of an acidified dichromate-dip (patented by the New Jersey Zinc Co.), which is being widely applied to zinc coatings and zinc base die castings, used in military and naval apparatus. The use of this treatment permits some reduction in the coating thickness of zinc.

Lead hot dip coatings have replaced zinc to a considerable extent on iron and steel hardware for outside atmosphere exposures. Since these coatings are not entirely free from pinholes, a certain amount of rust-staining appears, but the coatings provide satisfactory protection to parts other than those having thin metal sections.

Plated Finishes

Heavy copper plate produced by one of the rapid bright processes has proved a suitable substitute for brass in many applications. Where appearance is of importance, the use of "water-dip" lacquers following plating to reduce fingerprinting and tarnishing has proved popular.

Nickel conservation has required the elimination of nickel-chromium finishes both in civilian and war products, except where necessary for functional reasons. Bright zinc coatings have been found satisfactory substitutes for nickel-chromium in many cases.

Paints and Lacquers

In the organic coating field, new resins and solvents have been developed. Maleic anhydride has become widely used in place of phthalic anhydride in resin manufacture. Soy and linseed oil modified alkyds and modified linseed oil vehicles with rosins, ester gums, and other rosin esters, particularly the "Pentalyn" types, have replaced more familiar materials. Nitroparaffins obtained by nitration of methane, ethane, and propane have been developed as components of solvents for cellulosic esters and vinyl resins.

Resin emulsion vehicles consisting of a water dispersion of alkyd type resins have found use in both clear and pigmented coatings. These may be applied to wet or porous surfaces and the resulting coatings are comparable in durability to good oil paints, and their use for camouflage purposes is rapidly increasing. It is to be noted that the use of these paints conserves solvents and drying oils. Zinc chromate primers are being generally specified in finishes for war equipment. The improved product, known as zinc tetroxy chromate, has become available on a tonnage basis.

Improvements have been made in the equipment for flame descaling structural steel surfaces and the process has been extended to the surface treatment of forgings and castings preparatory to painting.

Cleaning and Pickling

by Vernon A. Lamb

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Developments in cleaning and pickling during 1941 were reviewed by Hall.[1] The necessity for wartime economy of materials has prompted papers on solvent economy by Anderson[2] and by Jesson.[3] It is pointed out that much solvent can be saved by proper technique in degreasing and by recovering solvent from dirty solvent and degreaser sludge. Dinley[4] discusses the use of volatile organic bases in chlorinated degreaser solvents. The addition of this type of basic compound to the solvent prevents the corrosion of degreasing machines by neutralizing the hydrochloric acid which is formed by the hydrolysis of the solvent.

Cleaning Compounds

The development of cleaners especially adapted to anodic cleaning has led to an increase in the use of this method. One of the advantages claimed for anodic cleaning is that steel cleaned by this process is free from hydrogen embrittlement. The advantages of the use of rectifiers as a power source in this type of cleaning are discussed by Leever and Bogle.[5]

A novel new method for quantitative evaluation of the effectiveness of metal-cleaning compounds and procedures has been recently described by Morgan and Lankler.[6] In their method, the fluorescent radiation from a test panel is photographed. The intensity of the fluorescence is proportional to the amount of oil on the panel. The procedure was applied to a study of the detergent effectiveness of a wetting agent.[7]

The results show that the wetting agent produces a definite improvement in the cleaning efficiencies of alkali cleaners, by making possible shorter cleaning times, lower operating temperatures, and lower concentrations of detergents. It remains to be seen whether applications of this method will lead to further improvements in cleaners.

Among the patents on cleaners granted in 1942 are those to Miller[8] for non-etching cleaners for magnesium containing, *e.g.*, 3 per cent of phenol, citric acid, or a related compound, in a 3 per cent sulphuric acid solution. Metziger and Long[9] obtained a patent on a cleaner for tin which contains an alkali chromate and an alkali silicofluoride in addition to an alkaline detergent. They claim this cleaner does not form spangles on tin plate. Many new proprietary cleaners have been announced in the trade magazines by various commercial firms.

Iron Sulphate for Pickling

Metal pickling with ferric sulphate (trade name Ferrisul) is discussed by Percival, Dyer, and Taylor[10] and by Chamberlain.[11] The amount of metal pickled with ferric sulphate has increased rapidly the last few years. In the above two articles, data and operating directions are given for pickling stainless steel, copper, and copper alloys, for brightening copper alloys, for etching steel for adhesion of protective coatings, and for pickling of silicon and beryllium alloys.[11]

In most cases ferric sulphate gives results equal or superior to older pickling methods and is less expensive to use. The pickling reaction with this compound does not result in hydrogen evolution. Therefore hydrogen embrittlement and fuming and gassing do not occur. This development is important to the war program since essential nitrates and chromates, otherwise used in pickling operations, are released for more vital uses.

Aronsen and Berman[12] discuss procedures for "smutless pickling" of steel. For high carbon steels they recommend pickling in sulphuric acid followed by anodic treatment in a solution containing 50 to 100 grams/liter of sodium or potassium hydroxide. This passivates the steel and is claimed to make it rust resisting.

Flame Descaling

A development which serves the purpose of pickling is "flame descaling." This subject is discussed by Deck.[13] Flame descaling is carried out by very rapidly heating the surface scale on steel with a special oxyacetylene burner. Differential expansion causes the scale to buckle and pop off. Many alloy steels which resist the descaling action of both flame and pickle can be effectively descaled by a combination of the two treatments.

The process is being increasingly used to descale structural steel, blooms, billets, and plates. It is also being used to remove rust for preparing tanks, dams, ships, pipelines, etc. for painting.[14]

Numerous publications and patents on the utilization of waste pickle liquor indicate the importance of this problem. Gehm[15] proposes two processes. In the first the liquor is treated with sodium silicate and sodium carbonate. A ferric silicate precipitate is formed which could be used for smelting, as a dehydrating agent, a sulphide absorbent, or a pigment or filler. The filtrate yields a very pure grade of sodium sulphate. In the second process the liquor is treated with scrap iron and calcium chloride. The calcium sulphate precipitate has possibilities as a building material. The filtrate is chlorinated and yields a good grade of ferric chloride, suitable for general uses or for sewage treatment.

Van Antwerpen[16] discusses the "Ferron" process, in which spent liquor is mixed with a fibrous material and treated with slaked lime. The precipitated mixture of calcium sulphate, ferrous oxide, and fiber is suitable for building materials, such as wallboard, shingles, insulating blocks, etc. Construction and weathering tests with this material show much promise. One steel company is using the process on a commercial scale. A similar process is discussed by Willan.[17]

A new glass tank-lining was announced by the Pittsburgh Plate Glass Co. Several companies have announced new corrosion-proof plastic tank-linings. Many trade announcements of new metal washing machines, pickling equipment, etc., have appeared. Numerous patents relating to pickling have been issued during the year.

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Die Casting

by B. E. Sandell

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When engineers, designers, and procurement agencies found it necessary to secure rapid methods of production in order to satisfy the ever increasing needs of our war program, it was only natural that die casting should be one of the fabricating methods to receive attention — a method capable of producing vast quantities of castings of very intricate shape, and to a high degree of dimensional accuracy. These parts, so made, required but little additional fabrication as ejected from the casting die.

War requirements demand the use of great quantities of aluminum, magnesium, and zinc castings, a large number of which fit the requirements peculiar to the die casting method of fabrication, and furthermore, important savings of highly strategic materials may usually be expected in a die casting, superseding other manufacturing methods. Numerous examples of die cast products, formerly fabricated by the screw machine process, and including forging, sand casting, welding, and other methods of shape fabrication, have established the savings that can be expected in both material and labor, where die castings are adopted.

Its adaptability having been established, it remained to determine whether the alloys fitted to die casting practice could be relied upon to meet the service characteristics of the intended designs. Three important functions of this service rest in the physical requirements, the chemical characteristics, and the solidity of the finished parts.

The chemical and physical characteristics of the popular die casting materials were previously firmly established by the die casting committees of the American Society for Testing Materials. The work of these committees had extended over a number of years, and volumes of data were available to the engineer, covering these properties. These data, condensed and compiled, had been widely distributed. The work included the effect on physical characteristics, under many and varied conditions of application, and these were further supplemented by corrosion and weathering tests that indicated the chemical behavior of these materials.

The Cold Chamber Method

Solid and homogeneous castings have for years been available in zinc die castings, when cast in plunger type machines, but the assurance of solid castings, made from aluminum and magnesium, had only progressed as rapidly as the advance of new casting equipment employing a new principle of metal injection and operating technique.

This comparatively new method embodies the use of an injection cylinder, fitted with a hydraulically operated plunger or piston, which retains the molten or mushy metal only for the period required for introduction, and its injection into the die cavity.

It was early recognized that this "cold chamber" method of casting had great advantages over the old "air shot" method, but die gating technique, together with other features peculiar to operation, necessarily needed revision with the new method. It is true that great strides had already been made in perfecting this technique, but it must be admitted that the real advance was prompted by the war department's need for castings of maximum solidity, that could be relied upon to perform as required.

Quality Control

The use of X-ray equipment has aided materially in securing the desired results and this tool is now serving as an important adjunct in most of the control laboratories of the leading die casters. The accurate diagnosis of the ills that may contribute to unsound or otherwise nonhomogeneous castings has served well to assist the die casting technician in finding the causes for these troubles, and its place in the die casting industry will be a lasting one.

Spectographic control, also, has established its importance. There exists no substitute for the ease, speed, and accuracy that this tool lends to the control of zinc die casting materials and its advantages are rapidly being utilized for the control of all the die casting alloys.

With the aid of these tools the die casting technicians have broadened their ingenuity, and the remaining obstacle, "unsoundness," now too bows to scientific control and to the progressiveness of the die caster which he would not be denied.

The die casting industry, having won its "E," is now producing millions of castings for defense uses, and "around the clock" operation is common for most of the plants of the industry. We have accepted and met the challenge, and are now prepared and in a position to produce castings of a diversification of materials designed to comply with the service requirements of a long list of war products.

Powder Metallurgy

by Floyd C. Kelley

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Powder metallurgy finds its real usefulness in two broad fields: First, in the production of metal parts required in large numbers, which, because of shape or finish, need expensive and wasteful machining, but which in themselves call for no special physical properties, and second: Such parts as may have particular requirements in physical properties which cannot be normally produced by any other method. In the first field, small gears, cams, bearings, and sleeves may be cited as examples and cemented carbide tools, permanent magnets and refractory metal alloys in the second.

The year of 1942 has not been highly productive of things that are new in the field of powder metallurgy, due perhaps to the curtailment of production in all fields except those essential to the war effort. This does not mean there have been no new developments, but whatever is new may not be revealed until the end of the war. A review of the literature reveals no new outstanding developments, but rather a great expansion in lines already explored.

Government agencies have shown a keen interest in this particular field because of the fact that it offers promise for mass production of huge quantities of war materials by utilization of machines and equipment already available. An organization representing the powder metallurgy industry has been set up to cooperate with the government agencies. This organization will select those parts needed in the largest quantities which the industry can produce faster or more cheaply than by some other method. Time is an important factor in the production of war equipment.

If powder metallurgy is to be utilized to the fullest extent, the designing engineer must have data concerning the physical properties of the various classes of sintered metals. He must also be cognizant of the limitations of shapes which may be produced by this process. Such data are gradually being accumulated so that the users will have some idea of the scope of usefulness of these materials.

Hot-Worked Compacts

Experience has shown that sintered materials, which have been hot pressed, hot forged, or hot worked by any method, have greatly improved physical properties. There has been great interest in the hot working of sintered materials but the difficulties accompanying such a process, namely, maintaining the temperature of the material, die wear, welding of the compact to the die, die materials that will withstand sufficiently high pressure at the operating temperature and the maintenance of a suitable atmosphere to protect the powder of the compact from oxidation have thus far limited any extensive applications. It has been possible to produce a 0.7 per cent C, low chromium-molybdenum steel reduced 25 per cent by hot working, and heat treated which showed a tensile strength of 172,000 lbs. per sq. in. but the elongation and reduction of area were both very low. This illustrates the possibilities of alloy steels and only the future can tell to what extent they may be used.

If one examines the long list of metallic elements, it will be found that there are few, if any, which have not been used in the production of some product of powder metallurgy. Many compounds of these and other elements have also been utilized. The art is old. The encouraging outlook comes from the widespread interest in the development of new fields of application, the enlistment of many trained scientific individuals with varied experience into the experimental army, and the sponsorship by research laboratories and industry of continued research in this field.

Iron, Aluminum and Brass Parts

Experiments, men, money, and time will be sure to produce something new, but in all great developments time is an important factor. It is futile to predict what these new developments may be. It would not be surprising to find that research in this field might lead to entirely new and unexpected developments in other fields. The war has already increased the production of some classes of sintered materials 1500 to 2000 per cent and it is not unlikely that others may be affected to the same degree.

It would seem from our present knowledge that the greatest expansion of powder metallurgy might take place in the application of sintered iron products because of the cost of material. The future production of aluminum and brass parts looks bright also because they both press to a high density and when properly sintered change very little in size. They also have a bright, pleasing appearance and should have a wider application in instrument parts. There are difficulties to be overcome in the pressing of the former because of seizure in the dies and a good reducing atmosphere is essential if the brass is to come out untarnished.

Salvaging Process Scrap

by Robinson D. Bullard

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American Industry—the prodigal son with the horn of plenty—suffered a rude awakening some year and a half ago. It was suddenly realized that the "bottomless well" of unlimited resources had a bottom. The unprecedented demands of war-time America so strained our natural resources that it soon became evident that we must augment our dwindling raw material supplies. It was believed, and since has been proven, that universal conservation of industrial waste—a practice heretofore followed by but few—is by far the most logical solution to this problem. As the practice of industrial salvage became more wide-spread, it was natural that many new methods of processing scrap should be developed. Without any attempt to list them in order of their importance, a few of the more outstanding methods will be discussed.

Chips and Borings

The usual methods of handling chips and borings removed in machining operations have changed considerably. Where this material was usually thrown into one big pile without regard for various different metals, it is now the practice to segregate every type of chip by analysis. In plants where larger quantities must be handled, these chips are often crushed in order to reduce their volume for ease of storing and handling. Both crushing and briquetting can be applied successfully to practically all types of metal chips.

In many instances it has been found practical to briquet these chips in a hydraulic press, the advantage of this being that they can be readily remelted at their source or sent to a steel mill where not only re-melting losses will be greatly reduced, but a larger percentage of chips can be charged into a given heat at any one time. As a result of this, briquetted materials command a higher price.

Another development incident to chip salvage has been the pneumatic conveying of the chips during processing, which has proven exceptionally economical.

Oils and Solvents

It soon became evident that when chips were salvaged in this manner, the cutting oil which had formerly been lost could readily be reclaimed. When chips are crushed, it is a relatively simple problem to remove practically all of the oil by spinning them for a short time in a centrifugal extractor. Before this oil is re-used, however, it is usually best to give it a thorough cleaning by one of several methods which are now available.

Where large quantities of dirt and water are present in a mineral oil, one of the best ways of removing both of these simultaneously is with a centrifugal clarifier. On the other hand, where little water is present, or where this is not harmful, simply heating in a cone-bottom tank often suffices. Still another method which is finding wide acceptance is the use of one of several types of pressure filters which often contain some form of diatomaceous earth. These earths have the added advantage of removing unwanted acids and at the same time brightening oils which have darkened from service.

A logical consequence of these developments is to be found in the reclamation of waste lubricating oils. Properly processed, these oils may be re-used many times. There are available in some localities concerns which make a practice of re-refining used oils so successfully as to meet new oil standards. Sometimes where the cost of re-processing is not warranted, waste lubricating oils may be used as an excellent medium for cutting oil blending.

The scarcity of paints, lacquers and solvents has become so pronounced that the sludges from paint booths and solvents degreasing equipment is now being carefully preserved so that all pigments and solvents may be recovered from them. These materials are usually returned either to the supplier or to a re-processing plant where this work can be done with the greatest economy.

Reclaiming Tools and Parts

Cutting tools, once thought valueless after they were broken or ground to a certain point, have had their usefulness greatly extended by such developments as re-grinding worn cutters to smaller sizes, brazing broken tools, or building up broken portions with a high speed welding rod. Even when these methods are of no avail in salvaging a discarded cutter, it is common practice to re-cut or re-forge the scrap pieces into inserts which are cemented to steel shanks for use in a manner similar to that of carbide tipped tools. Recent developments indicate that it will soon be possible to recover the high metal values in carbide tips which have been broken, worn, or ground too small for usefulness.

Parts spoiled in the production line, heretofore discarded, have come in for new treatment. Where possible they are often brought back to size by plating, by metal spraying, or by welding. Where a part does not lend itself to any of these methods, the material can often be substituted for new stock in the manufacturing of some other part.

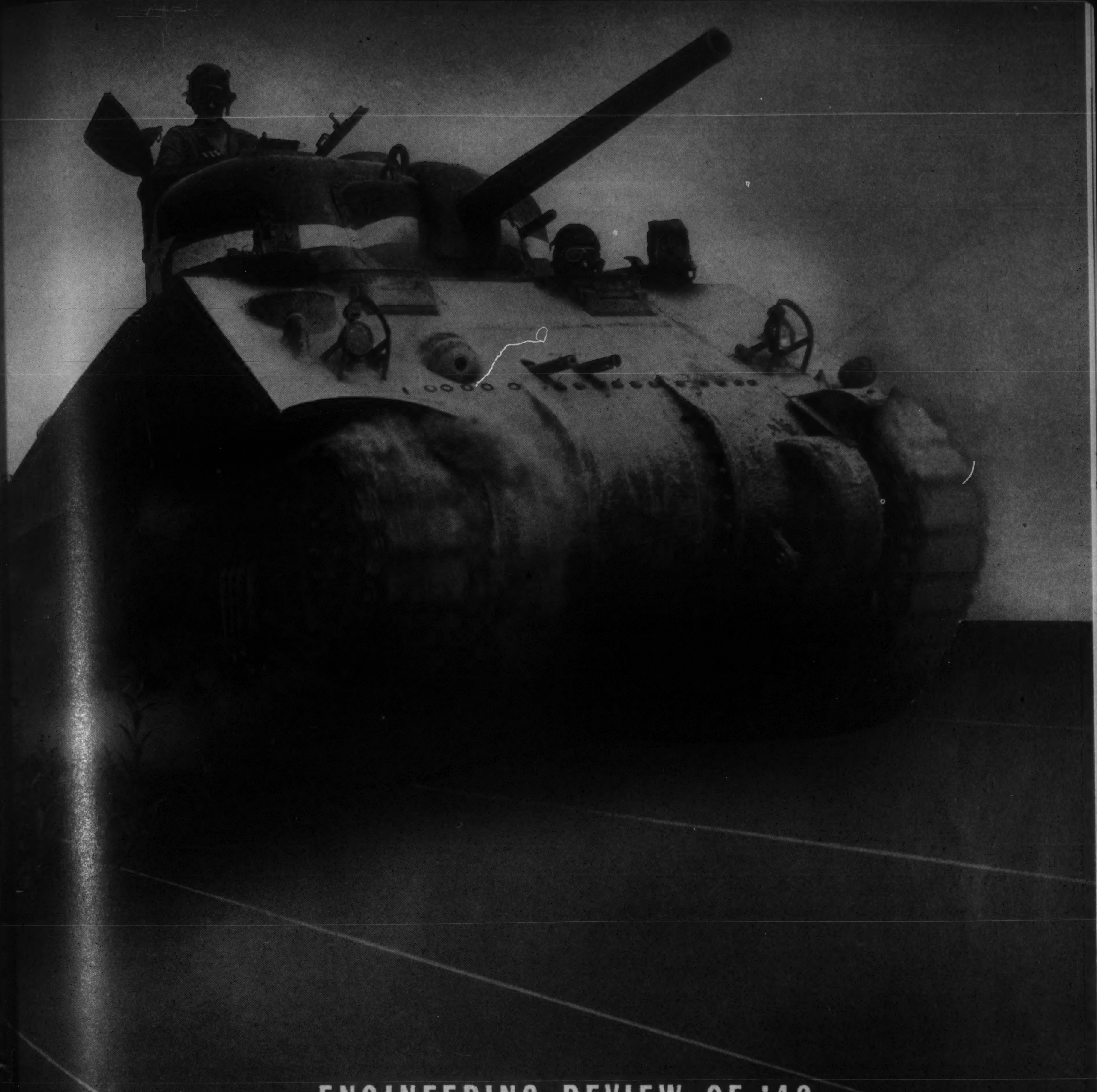
Miscellaneous Waste

Because of the scarcity of rubber, the insulation on copper wire is now being removed, usually by some method such as passing it between a pair of rollers. As a result of this, a better price can often be obtained for the copper and at the same time no rubber is lost.

Rather than using waste or rags only once and throwing them away, many plants have adopted the practice of using a shop wiping towel which is laundered many times, either in their own laundries or by an outside concern on a service basis.

Even such seemingly unimportant items as corrugated boxes, scrap wood and broken electric light bulbs have taken on a new meaning. Scrap wood can be made into palettes for tiering work, or crating or car blocking, while corrugated boxes are cut to smaller sizes to provide packing material. The broken electric light bulbs are dismantled for the brass and nickel alloy support wires which they contain.

It is by these and other means that it has been found possible to augment greatly our natural material supplies.



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Materials and Engineering Design

Ordnance Redesigns

by J. B. Nealey

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America's supply of raw materials is proving inadequate to the demand for the first time in its history. Particularly is this so of certain metals. As everyone knows, this is partly due to our supplying the United Nations as well as ourselves with combat material. As few realize, it is due also to the fact that armies today are mechanized, that is, all the fighting weapons of the armies (tanks, guns, etc.) are motorized for fast movement and the soldiers themselves are motor mounted.

The mechanized division today has 32 horsepower for every soldier in it. The spare parts program for the maintenance alone of such a motorized unit is colossal. To all this is added a terrific flow of materials into the new fighting weapons, the airplane, the anti-aircraft gun, fire controls, etc., to say nothing of battleships, transports, freighters, etc. to get all the equipment and the armies to battle fronts scattered all around the globe.

Redesigning Forced

The Ordnance Department of the U. S. Army, which is responsible for the design, development, procurement, and maintenance of all fighting weapons and motor transport of the American soldier, was forced to redesign many of the component parts of these items so that materials more abundant in supply could be substituted for those hard to get. Among the most common of metals strategic to the war effort, many of which are critical, are tin, magnesium, nickel, vanadium, molybdenum, aluminum, copper, tungsten, chromium, high grade zinc, manganese, alloy steel, sheet and strip steel, steel plates and a host of others.

Army Ordnance is the largest user of our steels, absorbing in its production over one-half of the tonnage required by the Armed Services. On part of the 1942 production and 1943 projections, our armed forces have devised ways and means of saving large quantities of nickel, chromium and vanadium.

One of the items changed was the brass cartridge case which was successfully converted to steel. This was a new problem to the U. S. Ordnance Dept. and industrial engineers who cooperated, but they succeeded, in a few short months, in accomplishing what European engineers had partially failed to achieve after many years of intensive effort. Some 50 American industrial firms participated in this program and all deserve plenty of credit. Copper savings occurring from this change, it is estimated, will amount to 100,000,000 lbs. this year and 591,000,000 lbs. in 1943. As brass is usually 70 per cent Cu and 30 per cent Zn, savings in the latter metal will be proportional.

Less Alloys in Armor Plate

Vanadium has been completely eliminated from cast armor plate and the nickel and chromium have been reduced to low percentages. Almost if not quite the same reductions, are expected for rolled homogeneous armor. As for rolled face-hardened armor, the savings in the alloying metals formerly employed, will probably run over half. As high as 2.5 and 4.5 Ni have been used in cast and homogeneous rolled armor respectively in the past.

Vast quantities of aluminum were saved for other purposes by redesigning the fuzes for the 60 and 81-mm. trench mortar shells, by the use of plastics. These fuzes are in three parts, body, head and booster cup. Formerly the first two were machined from bar stock and the third was die cast. It is impracticable to make artillery shell fuzes of plastics as rotational and setback stresses set up when fired from a high velocity rifled bore gun are too great.

However, one type of fuze formerly machined from aluminum bar stock was redesigned for casting from primary aluminum and then secondary metal. From 30 to 300 per cent scrap is produced when machining from bar stock and in aluminum this immediately becomes secondary while at least half of the die casting scrap can be thrown back into the pot. Therefore, this change freed many millions of pounds of primary aluminum for use in the airplane industry where secondary metal is unusable.

In order to keep the physicals as high as possible the Ordnance Department specifies that only pressure die casters be used. In all, some 416 components of 93 major items were redesigned to save 48,700,000 lbs. of primary aluminum in 1942 and 120,000,000 lbs. in 1943. The increased requirements for secondary aluminum were approximately nine and 120 millions lbs. respectively.

Saving Tin by Redesigning

Tinned copper liners, formerly used in smokeless powder containers to prevent static electricity, are now made from stainless steel (18% Cr). The new liner weighs but 3.87 lbs. as contrasted with 12.6

40-mm. M1 anti-aircraft gun, redesigned for welding. (Courtesy: Lincoln Arc Welding Foundation)

lbs. for the old. Zinc coated and enameled liners have been substituted for tin plate in ammunition boxes. The tin plate ends of fiber containers have been changed to galvanized iron and painted steel.

A few former tin bronze items are now produced from silicon bronze. In this connection it can be stated that there are some 200 types and sizes of bronze bushings and glands containing about 10 per cent Sn. Experiments are being carried on to make these of tinless bronze and steel which should leave at least 100,000 lbs. of tin available for other uses.

Cutting the tin content of solder and reducing the coating of terne plate from 15 to 2 lbs. have effected savings in tin in packing boxes for small arms ammunition which will amount to 1,450,000 lbs. in 1942 and 3,100,000 lbs. in 1943. Furthermore, the use of this in the field will shortly be eliminated entirely by the adoption of fiber containers which will set free an additional 5,000,000 lbs. in 1943 bringing the total savings for that year to more than 8,000,000 lbs.

Redesign and conversion also had the effect of partially redistributing the contract load so as to relieve an overloaded condition in certain types of plant, and shift some of this war work to others which needed it. Steel foundries with electric melting furnaces are loaded with orders for cast armor plate because of the vast tank program and these are in addition to large commitments for castings for artillery, combat vehicles, etc.

Using Stampings

As there appeared to be a minimum of contracts in the metal stamping industry, it was apparent to Ordnance officers and engineers that modern stamping practice involving forming, drawing and embossing combined with high tensile steels and welding and brazing offered an unusual opportunity in redesign. Full advantage was taken of this chance and a very long list of Ordnance items and components were redesigned to utilize sheet steel and presses. In addition to the reallocation of a heavy load, production rates were increased, and considerable savings in weight and scrap were effected in many instances.

Among the items so redesigned was the windshield (nose) used on many armor piercing shot. Formerly die cast in aluminum, it is now drawn from sheet steel. Bomb parts such as tail fins, lugs, nose and tail plugs, fin lock nuts, adaptors, etc., are now pressed from steel. Other items were primer tubes for high explosive shells, pistons, valve wheels, suspension guide fittings, trigger cover plates, supercharger housings, gun spring casings, etc. A stationary gear carrier, once machined from solid stainless steel, is now stamped from carbon steel and cadmium plated.

Gun Tubes and Carriages

A tremendous shortage in today's forging capacity was averted a few years ago by the Ordnance Department's development of centrifugal casting of artillery gun tubes ranging from 1 to 5-in. calibers. The perfecting and adaptation of cold working the steel (autofrettage) almost doubles the elastic limit of the gun steel. By casting and cold working a monobloc gun tube savings in time, labor and material of from 25 to 40 per cent are effected over the forging and assembling of the built up gun which it replaces. Due to these developments savings of 360 tons of nickel and 6 tons of vanadium are being made every month.

It was necessary for the Ordnance Department to design entirely new gun carriages for the present war so as to incorporate both mobility and high angle fire. In the new designs, full advantage was taken of the welding process to decrease their weight and simplify their manufacture. This was accomplished by substituting weldments (built up welded structures) for the heavy cast-steel parts which took more load from the foundry.

Design strength and rigidity are obtained and steel plates conserved by using box and U-sections where possible. One type of gun mount (90 mm.) was redesigned to replace aluminum plates with ribbed steel thereby saving millions of pounds of aluminum. (An anti-aircraft carriage, by the way, requires more than ten times as many drawings as the gun itself.)

A small portion of the forge shop load was transferred to the foundry by redesigning a number of machine parts which are now cast in iron and malleabilized. This change also served to increase production and save machining time and machine tools. A large foundry has converted a section to the casting of 60 mm. trench mortar shells using electric furnace steel and a triple heat treatment. In this case Ordnance specifications are not chemical, but physical, stating that the hollow shell, filled with an explosive, should fragment into pieces of a desired size when exploded. The foundry made a number of experiments and achieved the desired results. Ordnance conversion, in full swing, is far from finished.

Applications of the NE Steels

by Charles M. Parker

Secretary, General Technical Committee, American Iron and Steel Institute, New York

Industry has now had several months of experience with the NE 8000 series of National Emergency steels. They have been used in substantial tonnages in a myriad of applications. Laboratory tests have shown that they are at least equal to the more richly alloyed AISI-SAE steels and experience in the field has fully confirmed the results of the tests.

There is no intention to imply that the NE steels are the answer to all steel problems that exist or that may arise, but the facts are that they are capable of doing well most of the jobs which alloy steels have to do and that they do those jobs with restricted quantities of strategic or critical alloying elements.

Before discussing a few of the more difficult applications in which NE steels are performing satisfactorily, it may be desirable to give in a general way many of the pertinent facts which have been found.

In mechanical properties (tensile strength, yield point, reduction of area and elongation) the NE steels are virtually indistinguishable from the standard steels. In notched-bar sensitivity, or impact value, when compared with their equivalent standard steels under like conditions such as equivalent hardness or equivalent tensile strength, they have exhibited equal or superior values in both Izod and low-temperature Charpy tests.

Many heats of NE steels have been subjected to metallographic examination for cleanliness. Without exception, every heat examined exhibited a condition of cleanliness comparable to that of other fine-grained alloy steels, nearly all the ratings being A or B on the General Motors scale.

Reports received from steel producers and consumers alike stress the fact that NE steels exhibit a high degree of uniformity from heat to heat in chemical composition, hardenability and physical properties. One of the major reasons for that is the fact that all alloying elements are shown in the specification, and as a consequence all are controlled within rather close limits.

NE steels are doing many interesting and tough jobs. I suppose that at one time or another every man has watched with childlike admiration a tractor or bulldozer as it goes about its work moving tons of earth and rock before it. Many vital parts of those machines are being made from NE steels. In several models the power take-off shaft which transmits the might of the engine to the broad treads is made from NE 8949 which is proving to be superior to A 3240 and A 4340. Its high torsion-fatigue value makes it an admirable steel for that purpose. The gears which also transmit power and the tractor sprockets are made from NE 8720, which has been found to equal A 4620 in dynamometer-fatigue tests.

Some of the high-speed, heavy duty gears in mammoth truck transmissions are now made from NE 8744 flame hardened, replacing A 4140. The NE steel hardens equally well and exhibits superior ductility at high hardness.

NE 8124 is doing yeoman service in light truck transmission gears. Test gears ran 1,250,000 pinion cycles in the dynamometer-fatigue test — gears made of A 4320 invariably failed at 600,000 to 625,000 cycles.

NE 8620 has corrected a trouble which long existed in the plant of one manufacturer of motive equipment. Cam shafts made of A 4620 were difficult to straighten after carburizing and breakage ran 3 to 3.50 per cent. Shafts made of NE 8620 straighten more easily and breakage in straightening has dropped substantially.

NE steels are also helping America's railroads to carry the freight so necessary to our war effort. Some of our mammoths of the rails now have side rods, piston rods and crank pins made from NE 8442, replacing a special alloy steel devised especially for that service. Exhaustive tests showed the NE steel to be in no way inferior and service records so far support that conclusion.

Up and down the length and breadth of the land and in many foreign lands the NE steels are efficiently doing their part to win the war.

The Mad Materials Mix-Up

by A. Allan Bates

Of course we can't honestly say that we have ever recovered from the great depression which began so precipitously in 1929 and which was still growing deeper and gloomier three years later in spite of the official declaration that "prosperity is just around the corner." Undeniably a considerable reactivation of business resulted from the subsequent circus of Blue Eagles, Plowed-Under-Pigs, and Homo Leafraker* which, watered from Primed Pumps and fed from Ever-Normal Granaries, flourished in the land.

But this succession of zoological experiments to which we had recourse can hardly be described by devotees of individualism and free competition as routine steps toward recovery. And it should be remembered too that even though we had, by the Fall of 1939, again reached a rate of industrial production probably never surpassed in our previous history, we still had with us eight to ten million "unemployed."

But finally we were rescued—and with such force and overflowing fullness that we are still dazed.

Expansion in Metals

The hero of the occasion, however, was somewhat less than the Genghis Khan or the Caesar one might have expected. Instead Fate, indulging in a rather gauche sense of humor, provided as our rescuer a repugnant foul-mouthed racketeer called "Schickelgruber." With our "entry" into the war in 1940, we embarked on a national program of industrial expansion which might conceivably become the most significant aspect of the entire struggle.

As was to be expected this expansion started first in the metals industry and has continued on a scale which has the country gasping: "What are we going to do with all the stuff after the war? — Aluminum production up 500 per cent — a new industry, magnesium up 3000 per cent (or is it 5000 now?), iron and steel flowing in fantastic tonnages (enough from the United States alone to supply the whole world's customary needs) — It'll be a madhouse!"

Other Engineering Materials

Well, if it's to be a madhouse, it may as well follow the best current practice and be an all-out madhouse, so let's make apprehensive passing note of the fact that other engineering materials are following a similar course. Plastics, structural ceramics, plywood, and other forest products are all going to be in the battle, backed not only by increased production capacity, but also — and more importantly — by ability to take on jobs for which they were unsuited a short while ago.

For the research and development laboratories have been very busy and plywood, for example, will no longer be the thin, weak, splintery stuff we have known in the past. The synthetic resin treated plywood of the future will be a reliable engineering material, strong, resistant to weathering and other types of deterioration, and producible in light or heavy structural sections.

There is one fundamental fact so obvious that it is usually overlooked during our periods of worry about the future; in spite of the wartime unavailability of five or more million of our best workmen, now on military duty, we have no insurmountable trouble in producing and fabricating for use the flood of materials which are the source of our worry. Furthermore, while the present major uses are unfortunate and, we hope, temporary, there can scarcely be any doubt that the unsatisfied legitimate desires of mankind could provide plentiful outlet for all the materials we are now making and a great deal more.

In other words, our problem is not essentially technical — it is economic. (Keep your seats. This is not an introduction to Communism.) Therefore, when the Editor suggested a brief discussion of "The Mad Materials Mix-up" he laid himself wide open to just what he is getting.

Competition in Uses

Competition in uses among engineering materials is resolved by balance between two simple, basic considerations; (1) a particular material is demonstrated by actual service to have a clear technical superiority in a given application, or (2) commercial advantage dictates the choice. Cynics to the contrary notwithstanding, the first, or technical viewpoint is the more fundamental although much the less frequently applied. We make windows of glass instead of oiled paper and automotive axles of steel instead of, say, bronze because of technical considerations and regardless of the cost advantage or disadvantage.

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*Apparently a newly bred genus of Hominidae usually indistinguishable in appearance from Homo Sapiens but with habits described by certain authorities as resembling somewhat those of the Choloepus or sloth.

However, by an odd twist of mind, where technical superiority is wide and indisputable we usually dismiss the situation with the tacit, implied conclusion that there is no competition. When we worry about competition we are almost invariably thinking of the second, or economic aspect which, while usually straightforward enough, not infrequently becomes tangled with devious and suspect considerations such as reciprocity, advertising appeal, or even political machination.

After the War

Now there is no reason to believe that this situation will be basically altered after the war. If duralumin is clearly the best possible material from which to build stratoliners, then stratoliners will eventually be built of duralumin — only unless diligent research and good engineering develop another material still better than duralumin or another means of transport better than a stratoliner. However, if stainless steel, plywood and duralumin are of approximately equal technical merit in airplane construction then the choice will be made on the basis of economic advantage.

What really worries us then is a matter of economics — and so we arrive at the key question of our inquiry; after the war what will be meant by the phrase "economic advantage?" The new aluminum and magnesium plants, like many others of D.P.C. origin, were constructed without ordinary regard for commercial considerations.* Will they be operated the same way? Will the Government, having assumed control of our economic life, relax its grip in the post-war period? Will the much-argued "profit motive" again become the mainspring of our social structure?

It is not difficult to prove with mathematical exactness the conditions under which a capitalistic economy will be stable and successful — or unstable and unsuccessful. The actual attainment of the required conditions is another matter. In any case, until we know more of the answers to the stated or implied questions in this paragraph it is impossible to discuss any future "materials mix-up" or even to say that there will be one. There is, however, much that can be said which would be both interesting and profitable concerning the technical aspects of the future applications of both our old and our new metals and alloys. But the Editor said we could have 700 words for this article and we have already violated his trust.

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* Note the misleading way in which the writer uses the terms "commercial" and "economic"—as though they meant the same thing. Frequently, usually fortuitously, they do, but the exceptions are important.

Saving Non-Ferrous Metals

by Carter S. Cole

Chief Metals Section, Specifications Branch, Conservation Division, W.P.B.

Conservation has played, is playing, and will continue to play a very vital part in our War Effort. Conservation makes possible more planes, more guns, more tanks, more ships, and more ammunition *sooner*. Without it the procurement schedule of these important items would be considerably delayed, for we just do not have enough raw materials—especially non-ferrous metals—to meet all the requirements that we have to fulfill as the arsenal for the United Nations.

In World War I we were not called upon to arm our allies to the extent we are now. At that time also we had free access to the principal supplies of tin, rubber, etc., which are now in enemy hands. Changed conditions have resulted in a greater need for conservation, than ever existed before. Three stages of conservation have been apparent during the past two years.

Non-Essential Uses Banned

The first stage of our conservation program in regard to non-ferrous metals was to shut these metals off from non-essential uses by the now well known L and M Orders which have emanated from Washington. Aluminum and magnesium received attention first with the restrictions imposed in the Spring of 1941, and soon were under complete allocation control for aircraft and other essential uses. Nickel and copper orders followed shortly and, with each new amendment or addition, have become more and more restrictive.

Then came the zinc order, but no action was taken on tin until some time after Pearl Harbor. The restrictions then imposed on tin have been quite effective in channeling our restricted supplies of this metal to the points where its use is most essential. Lead too has been under control, but our present position in this metal is relatively much easier than for any of the others in the non-ferrous group.

Limitation Orders have reduced or eliminated the production of many items for civilian consumption, —for instance, automobiles, trucks, mechanical refrigerators, vacuum cleaners, etc. The combined effect of all these orders has been to make available for direct War Effort a large tonnage of nonferrous metals which normally went into civilian uses. But aluminum, magnesium, copper, nickel, tin, and other non-ferrous metals are needed in such large quantities for our armament program that additional steps have had to be taken.

One of the first of these was to see that all aluminum scrap was properly classified and segregated so that it could be returned to the mills and used to the best advantage. Copper mill scrap was also channeled back to the mills for direct remelting into other wrought products. Such measures are highly desirable because they reduce the amount of virgin metal which might otherwise be needed for wrought products used in the armament program. However, particularly in the field of copper, much of this mill scrap had formerly been used to sweeten alloy ingot. Many outlets, such as hardware, for contaminated scrap were also cut off by restrictive orders. As a consequence, the material readily available for making cast alloys contained impurities outside of current specification limits.

The Second Stage—Specifications

This fact led to the development of the second stage of conservation work. Specifications had always been written to get the best material we were willing to pay for. It was necessary, and still is, to write specifications that utilize the least critical material that will do the work in hand. The requirements in turn are based only on what is needed to bring the War to a successful conclusion. Just that and no more.

So the Specifications Branch of the Conservation Division, early in the year, sought the assistance of Committee B-5 of A.S.T.M. in drawing up emergency alternate specifications for copper-base-alloy castings so that the available material could be used to better advantage and also that tin might be conserved. This work was carried on in the Spring in cooperation with Government representatives on the Metals Committee of the F.S.E.C., and specifications for a number of emergency alternates and revised standard alloys were drawn up by A.S.T.M. and by the Federal Committee. During the late Spring the Mechanical Division of the Association of American Railroads also reviewed their specifications and made changes in line with A.S.T.M. action. During the Summer the Society of Automotive Engineers reviewed their specifications and made similar changes.

Likewise the specifications for solders and babbitts were reviewed by A.S.T.M., the Federal Committee, and the S.A.E. With the full cooperation of the producers and users of these materials, very satisfactory new lead-base babbitts and solders have been crystallized into specification form and with the impetus of the restrictions of the Tin Order have come into quite general use. Very considerable savings in tin have also been effected by conservation in tin plate. Electrolytic tin plate using 0.5 lb. of tin per base box has been adopted for many uses in place of the 1.5 lbs. per base box used in 1941. Only those products for which tin plate is actually needed can now be packed in tin cans and many items have been switched to black plate, to glass, or to other containers.

Specifications for emergency alternate grades of aluminum alloys have also been written by the Federal and the S.A.E. Committees to make the maximum possible use of available secondary metal. Thus the second stage of conservation was completed by about mid-year.

End-Use of Materials

The third stage of conservation has been the critical examination of end-use of the materials required in the armament program and for those items that still have to be made of non-ferrous metals in essential civilian uses. Wherever possible, direct substitution has been made. Where this has not been possible, the lowest type or grade of alloy is being adopted that will serve the purpose.

For instance, the well-known soda-and-acid fire extinguisher was an all-copper proposition. Its manufacture has been forbidden and an all-ferrous pump tank substituted. On Army purchases alone, during 1942, this resulted in a direct saving of many hundreds of tons of primary copper. Fire hose couplings and other hose fittings, except for shipboard use and except for swivels, are made of malleable iron. Fittings for shipboard use and swivels, instead of being the Underwriters' mix are made of a scrap yellow brass alloy. Late in the year there was developed and accepted by the Underwriters' Laboratories, a foam-type extinguisher with a lead-coated outer cylinder and vitreous enamel inner cylinder to replace the former all-copper construction.

Composition "M" for "G"

In the bronze specifications emphasis has been placed on avoiding the use of Composition "G" which, because of its low impurities, requires primary copper and tin. In many instances, such as propeller shaft sleeves in Maritime service, the specification has been changed to Composition "M" with large resultant savings in the use of primary metal. In other instances, such as in Navy valves and fittings, the specification requirements have been changed so that 85-5-5-5, which can be made wholly from secondary metal, is authorized.

Much work in this field still remains to be done to cut down the unwarranted use of Composition "G," silicon bronze, and other casting alloys requiring new metal. It is therefore the duty of everyone who knows of instances where changes in specifications can be made that will effect conservation, to call them to the attention of the proper authority. The Conservation Division of W.P.B. is working actively on such a program, will be glad to help and solicits your cooperation.

Metal-Form Applications

by D. Basch

General Electric Co., Schenectady, N. Y.

Present wartime application engineering is no longer directed towards establishing the most economical ways of manufacture as to dollars and cents. The main questions now are what material can be used that will meet the service requirements and will be available, and how can this material be fabricated into the desired final shape on available machinery, with the minimum of labor and material.

Metallic materials that in the past were freely at the engineer's disposal to choose from such as aluminum, magnesium, copper, tin, nickel, zinc, etc., are being used in such tremendous quantities for critical military purposes that available supplies are below even the most essential demands.

The situation is complicated by the fact that materials, which in themselves are scarce, are still harder to obtain in certain forms. Forgings and pressings are most critical due to the heavy load on hammer and press facilities; sheets, etc. only a little less so, again owing to the preempting of mills for military requirements; ingots for castings are more difficult to get in virgin high purity compositions than as secondary metals made from remelts, etc.

Production of strategic materials, with the exception of those (such as tin) which come from countries now occupied by the enemy, is being stepped up rapidly. Manufacturing facilities are being increased speedily but the demands are also increasing so that no change in the precarious supply situation may be expected for some time. The application engineer therefore when looking over the list of materials suitable for the purpose should first investigate whether or not he can use less restricted materials like cast or malleable iron, steel, plastics, lead, wood, silver, etc., and whether or not he can use secondary materials instead of virgin.

Of course, priorities will have a great influence, since the higher the priority the stronger the claim can be made for allocation of critical materials. Even then the engineer should not insist on a critical material when a less restricted material would be satisfactory since by foregoing his preferential status he may make critical material available for a less favored application where it might be highly desirable.

Next, he should consider how the material which he selects can be fabricated into finished form with the least labor, with the least loading of already overstrained manufacturing facilities and the least waste of materials on this basis.

Metal-Mold Castings

Special attention should be given to the possibility of using metal-mold castings (die and permanent mold) since they represent the most direct short cut from the raw material to the finished product with the least labor and material waste and can utilize secondary metals. Die casting in lead, zinc, aluminum, magnesium and brass offer the advantages over permanent mold castings of closer tolerances, sharper outlines and higher speed of production. On the other hand, they require more tooling and more critical die steels and are limited as to size and weight. War time needs have brought about the use of die castings for applications beyond peace time practice.

Improvements in machinery and technique, tighter all around control and inspection in the die casters plant, utilization of X-ray machines and spectrograph, intensification of metallurgical supervision and direction have resulted in commercial production (although not yet available from all die casters) of die castings with sound metallic structure, free from injurious porosity and segregations, which approach the physical properties of forgings and wrought material.

Die Castings of Aluminum and Zinc

Aluminum die castings, which now constitute by far the largest part of die casting production, can now be fully heat treated, without blistering or swelling, to unprecedently high mechanical strength—higher than in sand or permanent mold castings. Such castings can be used in responsible applications where failures would have serious effects on maintenance of service or consummation of important military objectives.

Similarly, special high grade zinc die castings are now available that, within the inherent limitations of zinc, such as brittleness at freezing temperatures, weight, and low melting point can safely be employed for responsibly stressed parts.

An attractive possibility is thus offered to substitute, particularly for forgings and for screw machine parts, where scarcity of machinery and waste of material in machining make substitution highly desirable.

Permanent mold castings in aluminum and magnesium fit in the program especially for large parts beyond the range of die castings and for small production jobs where the saving in time and labor needed to produce the mold, and of alloy steel as compared with the die casting die would offset the additional machining and material of the casting. Structurally, permanent mold castings compare with the high grade die castings, and are better than the general run of die castings.

Brass die and permanent mold castings are not used extensively primarily on account of the difficulty of getting die steels with sufficiently long life.

Plaster-Mold Castings

Other materials show more promise, such as the Plaster of Paris process, which employs Plaster of Paris molds, good for one shot only. Due to the low heat conductivity of plaster compared with steel or even sand, which means slow cooling, such castings excel in dense structure, thin sections, sharp outlines, smooth surface, close dimensions and are free from residual stresses.

On the other hand physical properties are apt to be slightly lower than in sand, owing to coarse-grained structure except where constituents are added to the metal to prevent grain growth. Production speed is slower than with die or permanent mold castings. Pattern equipment does not require alloy steel or extensive tooling. Plaster of Paris molds and cores lend themselves to most intricate designs, which would tax the ingenuity of the die designer for die or permanent mold castings.

Plaster of Paris castings are sometimes made in aluminum and zinc but there the regular die or permanent mold casting is too much of a competitor, except for exceedingly intricate parts.

Non-Metallics on the March

by Herbert R. Simonds
Consulting Engineer, New York

The Mosquito, the new British de Havilland reconnaissance bomber, and the newest addition to the RAF air fleets is the first all-wood—plastic-bonded plywood—combat plane to take to the air. She represents, apart from Allied air strength, one of the most striking examples of the completeness with which metal substitution can and is taking over.

This is not happening just in planes, nor is plywood the only substitution material. Among the important non-metal materials doing heavy duty for the war effort, wood may be given second place, a strong competitor in this regard to rubber. Plastics would probably take third place, followed in order by glass, asbestos, cement, ceramics, organic finishes and fibers. Many of these materials are doing the same work they have always done. Some, those with constantly developing applications, are taking over jobs formerly traditionally (and apparently permanently) confined to the metals.

Plywood, Ceramics, etc.

Plywood today makes the hulls of the PT boats, the assault boats, and has a reputable record as a glider and transport plane material. Lately it has emerged as a superior material for *combat* planes being in some ways less vulnerable to gun fire than aluminum and being lighter in weight, less expensive, and more easily repaired. Unlike aluminum it does not sustain the often-mortal jagged surface tear when hit by gunfire, sustaining instead the specific holes made by the bullets.

Plywood is also key among the substitute building materials that today make possible buildings using only 10 per cent of the critical materials formerly required. Plastics, glass, gypsum, tile and other clay products are today effecting in buildings a 90 per cent saving of woods and steels normally used.

Builders are now using, in addition to this all-duty plywood, other substitution materials. Glass and plastic piping and tubing carry liquids, gas, or even electric wires with a saving of 90 per cent of the metal formerly doing such work. Bathtubs and kitchen sinks are now being made of various non-critical materials, such as tile, reinforced stucco, concrete. Plywood bathtubs are going into all the new housing projects, replacing cast iron and pressed steel models. Water heaters, formerly made of copper, steel, and brass, are being replaced by units made of Pyrex glass tubing with a fiber-glass screen shell.

Plastics

Wall panels are made of fiber-board, gypsum board, and plastic-coated wall boards. Electrical insulation, even before the rubber shortage, had turned to plastics. Window panes will be increasingly made of non-shatterable acrylic resins (now also used for bomber noses), which allow greatly increased ultra violet ray transmission.

Many of the materials of substitution are materials that have been recalled to do jobs they had been forced to abdicate in the face of metal superiority. In some cases they are being given more sensible application, and they may remain on the job after the metals shortage eases. Plastics, however, because of their newness and because they are a group of materials with as many possible qualities as there are chemical formulas, are, generally speaking, *not* offering second-best characteristics. In many cases they offer attributes peculiarly their own. In many cases their substitution for metal is here to stay.

Steel and wood are the traditional load-bearing materials, materials used largely under tension. Plastics now emerge as a structural material that as yet cannot take all the stress carried by steel but, at the present early stage of development, can take far more than wood. The particular plastics material used for structural applications is the laminated wood. Laminated roof trusses, beams, arches that span 300 ft., can be seen in innumerable Army encampments. Definitely, these plastic-bonded woods will give steel strong competition in the post-war eras.

Machine Parts

Substitution for metals in the industrial scene embraces machine tools and parts, as well as the vast amount of resale parts—parts later incorporated into the assembly of another product. The tremendous use of plastics resale parts in the automotive industry (dashboards, steering wheels, handles, gages, bezels, dial faces, and in some cases stainless seating upholstery and gas tanks, etc.), which is second only as a plastics purchaser to the electrical insulation industry, gives some idea of the aggregate significance of substitution done with this group of materials.

The laminates of fiber, fabric, and paper do the heavy duty as machine parts. These laminates and the cast phenolics, are turned out as gears, roll-neck bearings, bus bar supports, elevator gibs, brush holders, condensor separators, truck wheels (easy on factory floor and chemically inert), pump valves, switch blocks, fuse housings, cams, pulleys, switch insulators, sockets, washers, gaskets.

The resale parts made of stainless steel, Monel, plated materials and highly finished steels, have to a great extent gone over to plastics. Greater color variety, elimination of paint maintenance plus lower fabrication costs have been instrumental in causing one metal plant to turn 90 per cent of its resale business over to plastics; less complete conversions figure in many other plants. These resale pieces, usually, are not required to take great stress. They do not need the tensile strength of the steel, yet benefit greatly by the color, touch, and long-wear qualities of plastics.

A recent and definitely emergency substitution field is that of the container industry. Vast amounts of cellophane and acetate sheet are going into paper containers holding food products, such as butter, lard, flour, cereals, for overseas shipment. Even before the war shortages occurred, there was a shift in the beer industry from tin to glass, and in the milk bottling from glass to chemically treated paperboard.

Some Specific Instances

Following are a few of the more recent and significant substitution cases:

A plastic and paper printing plate for off-set printing will reportedly save 1500 tons of zinc per year. The light plate is now being used by the Army map service and the Army engineers. WPB also reports an all-plastic plate of cellulose acetate which will be used for electrotyping, thus replacing copper.

A corrugated sheet steel substitute is made from two sheets of heavy felt saturated with a newly-developed resino-bituminous compound, which upon application of heat and pressure, becomes a hard, rigid, light-weight, moisture-proof building material.

A collapsible cellulose acetate tube replaces the tin and lead toothpaste and shaving cream type tube. Three leading producers make annually approximately 100 million tubes; the plastic tubes produced at this rate will save 2,300,000 lbs. of tin and a greater amount of lead.

Laminated paper wingtips, rudders and ailerons for aircraft are being experimented with as one solution to the steel and aluminum shortage. An experimental wing tip proves to be much lighter in weight, 40 per cent stronger than aluminum, withstanding a test strain of 2800 lbs.

A plastics bugle of cellulose acetate has the official sanction of the Army Ordnance.

Plastic baffles on air deflectors and plastics push rod housings now ride the skyways with the Wright aircraft engines. Replacing sheet-aluminum, the material, besides effecting a metal saving, more than doubles the service life of the parts involved, decreases the engine weight, reduces manufacturing time and costs.

Two thousand tons of steel will be saved annually by the Standard Oil Co. of Indiana adopting a new plywood drum for handling heavy lubricants. Plywood shortage, due to its use for airplanes, may eliminate this substitution.

Reference Table of

NEW MATERIALS AND FINISHES OF 1942

for Design and Processing

Compiled by Fred P. Peters, Managing Editor

This year's edition of our annual table of new materials and finishes introduced during the last 12 or 15 months is different from last year's in several ways. In scope it is larger, since in addition to the usual listing of metals and non-metallic materials for *design and construction,* there is now included a section on *processing* materials (quenching oils, lubricants, fluxes, cleaning compounds, solvents, etc.). New non-metallic materials for design were more numerous, in proportion, than new metals and alloys introduced to the engineering public. There were virtually no new proprietary constructional steels developed, the industry-wide wartime work on the new NE steels having completely shut out development of new "commercial" steels.

Not all the products described are strictly "new." Some were developed in 1940 or 1941 but received little widespread use until 1942; others represent significant modifications of older materials or finishes. Still others are new products for their manufacturers, although other companies may have had similar materials on the market for some time. Each, however, appears in these tables for the first time, and each represents a new product, brandname or supply source to challenge the engineer's attention. Of course, supply situations being what they obviously are, a listing in this Table is no assurance of a material's continuing availability.

The statements appearing in the Table are for the most part based on the claims of the manufacturers concerned and do not necessarily constitute either a recommendation by this magazine of any products listed or agreement with the claims expressed. Every effort has been made, however, to include only factual material.

The Table is divided into 10 sections, as follows:

1. Non-ferrous Alloys
2. Engineering and Mach'y Steels
3. Tool Steels and Tool Materials
4. Iron-base Materials
5. Powder Metallurgy Products
6. Welding Rods, Brazing Alloys and Solders
7. Metallurgical Reagents
8. Non-Metals for Design-Use
9. Finishes and Coatings
10. Processing Materials

Within each section, the products are arranged alphabetically by trade names.

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Non-Ferrous Alloys (See also Powder Metallurgy Products; Welding Rods, etc., Metallurgical Agents)	Aluminum Brass	76 Cu, 22 Zn, 2 Al	Available as tubing. High resistance to corrosion.	Condenser tubes.	Wolverine Tube Div., Detroit
	Bronze (Special)	88.5 Cu, 1 Ni, 0.2 P, 9.8 Zn, 0.5 Te	Age-hardenable, high strength, free-machining, readily forged. High corrosion resistance.	Structural uses requiring high strength and machinability or forgeability, or both.	Chase Brass & Copper Co., Waterbury, Conn.
	Cerrosafe	Bismuth - lead - tin-cadmium alloy	Melts at 190° F.; shrinkage is practically negligible, and mold distortion is absent.	For proof-casting; as a filler behind small parts to be machined or cast, etc.	Cerro de Pasco Copper Co., New York
	Cupro-nickel	70 Cu, 30 Ni	Available as tubing. Has high corrosion resistance.	Condenser tubes.	Wolverine Tube Div., Detroit
	Defender Metal	80-83 Pb, 5.5-7.5 Sn, 10-12 Sb, no Zn or Al	Tough, malleable lead-base substitute for regular tin-base babbitt. Withstand shocks without cracking.	Shock-load bearings, connecting rods, trap-rock crushers, crank pins, etc.	Magnolia Metal Co., Elizabeth, N. J.
	Domestic Silver	Fine (999+) or Sterling (975)	High conductivity, good corrosion resistance. No restrictions on use—available without priorities.	Substitute for copper, brass, aluminum, nickel, etc. Excellent for replacement and repair parts.	Sherman & Co., New York
	Elkonite D-54	Electrical - contact alloy	High electrical conductivity, low contact resistance. Non-sticking.	Contacts for heavy-duty relays.	P. R. Mallory & Co., Inc., Indianapolis, Ind.
	Fasaloy No. 106	Silver-copper	High electrical conductivity, with spring temper.	Electrical contacts and spring members in one piece.	Fansteel Metallurgical Corp., No. Chicago, Ill.
	Fastell Alloys	Ag-W, Ag-Mo, Cu-W	High conductivity with resistance to arc erosion. Made by powder metallurgy processes.	Heavy-duty electrical contacts.	Fansteel Metallurgical Corp., No. Chicago, Ill.

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Non-Ferrous Alloys (See also Powder Metallurgy Products; Welding Rods, etc.; Metallurgical Agents)	Federated "G" Babbitt	0.75 Sn, 3 As, 12.5 Sb, Bal. lead	Lead-base babbitt with tensile strength and Brinell hardness at high temperatures comparable to tin babbitts.	All purpose babbitts for precision bearings.	Federated Metals Div., Acme Smelting & Refining Co., New York
	Federated "S" Babbitt	1.0 Sn, 1.10 As, 15 Sb, 0.5 Cu, Bal. lead	Lead-base babbitt, with slightly greater ductility than "G," but slightly lower high-temperature properties.		
	G-12	Electrical-contact alloy	Low contact resistance, non-welding.	Circuit-breaker contacts.	P. R. Mallory & Co., Inc., Indianapolis
	Galvalloy	Low-melting, corrosion - resistant alloy	Forms good bond with aluminum alloys, without flux. Applied by rubbing the material against heated surfaces to be joined.	As an aluminum solder, applied without flux; for protecting welded seams on galvanized steel; for repair of aluminum castings.	Metalloy Products Co., Los Angeles
	Grac	Lead, hardened with Sn (10%), Cu, Sb, As and Cd or Ni. Contains graphite	Anti-friction alloy; low coeff. friction; stability through repeated remeltings. Resists seizing, compression and damage from oil loss.	Satisfactory alternate for high-tin babbitt bearings.	Graphitized Alloys Corp., New York
	Mazlo Am-C52S	3 Al, 1 Zn, 0.2 Mn, Bal. magnesium	Lightness and strength, plus high resistance to corrosion and good working characteristics.	Moderately-stressed airplane parts requiring good workability (sheet, extruded shapes, tubing).	American Magnesium Corp., Cleveland
	Nada NT	87 Cu, 3.75 Ni, 3.75 Sn, 0.75 Pb, Bal. Zn	Bronze casting alloy of Solid solution type. 45,000 p.s.i. tensile, 19,900 yield, 40% elong., 31 ft.-lb. Izod.	Pressure and structural castings.	Nassau Smelting & Refining Co., New York
	Nickel Phosphor Bronze	98.68 Cu, 1.10 Ni, 0.22 P	Wire and strip with high conductivity, high strength, high fatigue resistance.	High strength conductors and springs.	Chase Brass & Copper Co., Inc., Waterbury, Conn.
	Pyramid Metal	78-81 Pb, 16-18 Sb, 0-2 Sn, + others, no Zn or Al	Hard, close-grained lead-base babbitt. Withstands heavy, sustained pressures.	Railroad, turbine and large motor bearings, rolling-mill bearings, etc. Substitutes for hard grade of regular tin babbitt.	Magnolia Metal Co., Elizabeth, N. J.
	TC-53 TC-10 TC-20	Contact alloys	High hardness and wear resistance, with good conductivity.	Electrodes for upsetting projection (resistance) welding.	P. R. Mallory & Co., Inc., Indianapolis, Ind.

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Engineering and Machinery Steels	NE 8020	1.0-1.3 Mn, .10-.20 Mo, .18-.23 C	These manganese - molybdenum steels have high impact values and fatigue resistance, and are easy to forge, machine, weld and heat treat.	Substitute for S.A.E. 2320, 3120, 4023, 4119, 4615, 4120, etc.	These steels were developed by engineers associated with the American Iron and Steel Institute in cooperation with the Society of Automotive Engineers and other groups. The NE steels are virtually the only new engineering and machinery steels developed during 1942. This list comprises only those NE steels that are "official" as of Jan. 1st and likely to be melted in the next few months. The list does not include several NE steels, such as 8022, 8339, 8715, 8722, 8735, 8739, 8740, 8744, 8749, 8949, etc. that have been recently deleted from the list (although considerable stocks of some of them can still be purchased). The manufacturers of these steels are the steel industry as a whole, and information on sources of supply for specific steels may be had from the mills and warehouses and the A.I.S.I.
	NE 8442	1.3-1.6 Mn, .30-.40 Mo, .40-.45 C		Substitute for S.A.E. 2340, 2345, 3140, 3145, 4140, etc. in larger sizes.	
	NE 8613	.40-.70 Ni, .40-.60 Cr, .15-.25 Mo, .70-.90 Mn (5-point C ranges)	These nickel - chromium - molybdenum steels make good use as alloying agents of the "residual" alloy impurities present in ordinary scrap. They have good all-'round mechanical, working, heat treating and service properties.	Substitute for S.A.E. 3115, 4615, etc.	
	NE 8617			Substitute for S.A.E. 4615, 4119, etc.	
	NE 8620			Substitute for S.A.E. 2320, 3120, 4023, 4119, 6120, etc.	
	NE 8630			Substitute for S.A.E. 2330, 3130, 4130, 6130, etc.	
	NE 8635	.40-.70 Ni, .40-.60 Cr, .15-.25 Mo, .75-1.0 Mn (5-point C ranges)		Substitute for S.A.E. 2335, 3135, 4037, 4137, etc.	
	NE 8637			Substitute for S.A.E. 2335, 3135, 4037, 4137, etc.	
	NE 8640			Substitute for S.A.E. 4137, 4130, 5140, 4640, etc.	
	NE 8642			Substitute for S.A.E. 3140, 4142, 6145, 2345, etc.	
	NE 8645			Substitute for S.A.E. 3140, 4140, 3145, 6145, etc.	
	NE 8650			Substitute for S.A.E. 2345, 3145, 3240, 3250, 4340, etc.	
	NE 8720	as above but .20-.30 Mo		Substitute for S.A.E. 2320, 3120, 4119, 4615, 6120, etc.	
	NE 9415	.20-.50 Ni, .20-.40 Cr, .08-.15 Mo, .80-1.1 Mn, .40-.60 Si (5-point C range)	These steels are similar to the 8600-8700 series but make the maximum use of the alloy "residuals" in scrap, and achieve their results with lower molybdenum content. At the moment, they are the most "available" of all the NE steels.	Substitute for S.A.E. 2315, 2320, 3115, 3120, 4615, etc.	
	NE 9420			Substitute for S.A.E. 2320, 3120, 4023, 4119, 4615, 6120, etc.	
	NE 9422			Substitute for S.A.E. 2320, 4023, 4615, 6120, etc.	
	NE 9430	as above, except Mn, 0.9-1.20		Substitute for S.A.E. 2330, 3130, 4130, 6130	
	NE 9435			Substitute for S.A.E. 2335, 3135, 4037, 4137	
	NE 9437			Substitute for S.A.E. 2335, 3135, 4037, 4137	
	NE 9440			Substitute for S.A.E. 2340, 2345, 3140, etc.	

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Engineering and Machinery Steels	NE 9442	as 9440, except Mn, 1.0-1.3	These steels are similar to the 8600-8700 series but make the maximum use of the alloy "residuals" in scrap, and achieve their results with lower molybdenum content. At the moment they are the most "available" of all the NE steels.	Substitute for S.A.E. 2340, 2345, 3140, 3145, 3150, 4140, 4150, 6150, etc.	
	NE 9445			Substitute for S.A.E. 2345, 3145, 4150, etc.	
	NE 9450	as above, except Mn, 1.2-1.5		Substitute for S.A.E. 3145, 3150, 4150, 6150, etc.	
	NE 9537	.40-.70 Ni, .40-.60 Cr, .15-.25 Mo, 1.2-1.5 Mn,		Substitute for S.A.E. 2340, 3140, 3145, 4140, etc. in larger sizes.	
	NE 9540	.40-.60 Si (5-point C ranges)		Substitute for S.A.E. 2340, 2345, 3140, 3145, 4140, etc. in larger sizes.	
	NE 9542			Substitute for S.A.E. 2340, 2345, 3140, 3145, 3150, 4140, 4150, etc. in larger sizes.	
	NE 9550			Substitute for S.A.E. 2345, 3145, 3150, 4150, 6150, etc. in larger sizes.	
	NE 9630	1.2-1.5 Mn, .40-.60 Cr, .40-.60 Si (5-point C ranges)	These nickel-free steels have high hardenability and can be made in the absence of "high-residual" scrap — in other words by mills with very "pure" home scrap.	Substitute for S.A.E. 2330, 3130, 4130, 5130, 4037, 4042, etc.	
	NE 9635			Substitute for S.A.E. 4047, 3135, 5135, 5140, 6140, etc.	
	NE 9637			Substitute for S.A.E. 4137, 4640, 5140, etc.	
	NE 9640			Substitute for S.A.E. 3045, 3140, 4140, 4645, etc.	
	NE 9642	1.3-1.6 Mn, .40-.60 Cr, .40-.60 Si (5-point C ranges)		Substitute for S.A.E. 2340, 3141, 3240, 4142, etc.	
	NE 9645			Substitute for S.A.E. 2345, 3145, 4145, 5150, 6150, etc.	
	NE 9650			Substitute for S.A.E. 2350, 3150, 3250, 4150, etc.	

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Tool Steels and Tool Materials	Cromoco	1.6 C, 12 Cr, 1 Co, 1 Mo	Air hardening die steel with improved machinability as-annealed. High hardness, deep-hardening, superior abrasion-resistance.	Cutting and forming dies, where highest production is desired.	Firth-Sterling Steel Co., McKeesport, Pa.
	Hardsteel	Very hard alloy	Exceptional hardness. High shock resistance and heat resistance.	Drilling, countersinking, boring, reaming and general machining of hardened steel, armor plate, etc.	Black Drill Co., Cleveland
	Stellite 98M2	Cobalt-chromium — tungsten	Hard tool material, ideal for high rates of metal removal. Permits higher cutting speeds. Less frequent regrindings.	For machining steel at high speeds. Available in standard solid bits and welded-tip tools.	Haynes Stellite Co., Kokoma, Ind.
	TA T-04 T-16 T-31	Sintered tungsten titanium carbides, containing cobalt	For steel-cutting carbide tools. Prices comparable with high speed steel, but with greater productivity.	Whole range of steel machining and cutting. "TA" is general purpose material. "T-31" hardest grade, for precision boring, etc.	Firth-Sterling Steel Co., McKeesport, Pa.
	TMC	Low - Tungsten molybdenum high speed steel	Comparable to 18-4-1, but is lighter and has a lower hardening temperature.	Cutting tools for fast machining; substitute for 18-4-1 high speed steel.	Jessop Steel Co., Washington, Pa.
Iron-Base Materials (See also Engineering and Machinery Steels; Tool Steels, Powder Metallurgy Products; Welding Rods; and Metallurgical Agents)	Copper-Clad Steel	Steel with 10-20% copper cladding	Cladding may be on one or both sides as desired. Provides surface qualities of copper, but with conservation in amount.	Bearings, chemical apparatus and process equipment.	Revere Copper & Brass, Inc., New York
	Elverite D	Molybdenum chilled iron	High wear resistance.	Very hard, abrasion-resistant parts.	Babcock & Wilcox Co., New York
	SA-32	Low-alloy iron castings	Resistance to growth and serviceability in 1000-1400° F. range. Saves nickel and chromium.	Parts for industrial furnaces, and general uses at 1000-1400° F., under conditions of limited thermal or mechanical shock.	Sterling Alloys, Inc., Woburn, (Boston) Mass.
	Super-Y	Alloy malleable iron castings	Very high yield strength, good castability, superior shock-resistance and machinability.	As a replacement for steel castings, or wherever a casting material midway between malleable iron and steel is sought.	Chicago Malleable Castings Co., Chicago
	Su Veneer	Flat steel, clad (one or both sides) with another metal	Cladding may be whatever metal is desired, conserves critical corrosion — resistant alloys.	Corrosion-resistant stampings and drawn parts.	Superior Steel Corp., Carnegie, Pa.

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Powder Metallurgy Products	Damascite	Molded iron parts	Parts have strength and ductility equal to low-carbon steel.	Replaces machine pads made from forgings, bar, castings, stampings, etc.	Chrysler Corp., Ample Div., Detroit
	Mallory 1000	Heavy alloy	High strength, density and specific gravity.	"Confidential."	P. R. Mallory & Co., Inc., Indianapolis, Ind.
	Pomet 309	Molded iron parts with 0.1 C	High density and strength. Can be hardened by heat treatment.	Machine, ordnance and instrument parts.	Powder Metallurgy, Inc., Long Island City, N. Y.
	Powdiron	iron-base parts	Porous iron-base material, with or without copper and other alloys. Contains controlled amounts of impregnated lubricants.	For iron-powder parts and bearings. Saves tin. Available in 3 formulas.	Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.
	Self-lube	Porous iron bearings	Made from powdered iron, molded to shape desired. Porosity (25-35%) is impregnated with oil to give low-friction, self-lubricating properties.	To replace porous bronze bearings or for general bearing applications where elimination of grease cups or oil vents is desirable.	Keystone Carbon Co., Inc., St. Mary's, Pa.
	Stressite Brass or Bronze	7.0/30 brass (or others) or tin bronze parts	Molded parts of high strength and high density. Materials are corrosion-resistant. (There is also a stressite copper for high-conductivity requirements.)	Machine parts requiring fairly high physical properties, or to replace forgings, die castings, screw machine products, etc.	Chrysler Corp., Ample Div., Detroit
	Stressite iron	iron parts	Fairly high physical properties, together with high density (Stressite Iron No. 16 is a porous grade.)	Machine parts. (Stressite Iron No. 16 used for heavy-duty bearings.	Chrysler Corp., Ample Div., Detroit
Welding Rods, Brazing Alloys and Solders	Aluminum Solder	Solder for "difficult" metals	A free-flowing, high strength, corrosion resistant solder for "hard-to-solder" metals.	Specially developed for soldering aluminum, magnesium, zinc, nickel and other alloys.	Lloyd S. Johnson Co., Chicago
	Ampco-Trode 10	Welding rod, 89 Cu, 10 Al, 1 Fe	High strength and ductility. Not hot short. Usable by metal arc, carbon-arc or gas welding.	Arc welding brass and bronze. Arc-brazing.. Malleable iron, gray iron and steel.	Ampco Metal, Inc., Milwaukee, Wis.
	Castolin No. 16 C	Copper-base alloy and flux	Low melting point and high strength. Economical flow. Lower cost than silver solder.	Designed especially for rapid brazing of steel with high frequency current or in furnaces.	Eutectic Welding Alloys Co., New York
	Chromang	Modified 19/9 Cr-Ni stainless	An all-position electrode involving no sacrifice of speed in the down hand position.	For welding armor.	Arcos Corp., Philadelphia

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Welding Rods, Brazing Alloys and Solders	Coast Metals No. X (acetylene) and 100 X (arc)	Hard-facing composition; iron-base, Cr, Ni, Mo	Retains hardness at elevated temperatures. High impact strength, good wear resistance. Forgeable.	Hot shear blades.	Coast Metals, Inc., Canton, O.
	Coast Metals No. 18 (acetylene) and 118 (arc)	Hard-facing alloy, iron-base with Cr, Ni, Mo, Co	Excellent welding properties and impact resistance at high temperatures. Machinable with carbide tools.	Engine valves, seat rings. Superheated steam valves. Pump shafts and sleeves. Hot-work dies and punches.	
	Durface	Hard-facing alloy; iron-base	High hardness, excellent wear resistance and corrosion resistance.	For producing (or restoring) hard, wear-resistant surfaces on iron and steel parts and tools.	Eutectic Welding Alloys Co., New York
	Federated "ST" Solders	6-30 Sn, 1.75 Ag, 0.5-5 Bi, 0.5 Sb Bal. lead	Low-tin solders. Free-flowing, easy to handle. Require 25-50° F. higher temperatures than ordinary solders.	All types of soldering, in place of usual high-tin solders.	Federated Metals Div., American Smelting & Refining Co., New York
	Galv-Weld	Lead-base solder	Low-tin content. Free-flowing. Excellent electrical properties.	Soldering and tinning.	Galv-Weld, Inc., Dayton, Ohio
	Nu-Braze No. 4	Silver brazing alloy (Federal and Navy Spec. No. 4)	High melting ability. Joints have high tensile strength, often greater than parent metals.	Brazing ferrous and nonferrous metals, like or unlike. Can replace welded joints.	Sherman & Co., New York
	Ready-flow	Silver brazing alloy (56% Ag)	Low melting point of 1165° F., great strength. Contains no cadmium.	Variety of brazing operations, especially the joining of dissimilar metals and where a low melting point is needed.	American Platinum Works, Newark, N. J.
	Stoodite K	Hardfacing material—contains Fe, Mo, W, C, Si, Mn	Produces very hard, wear-resistant surfaces by welding-on process.	Agricultural tools, cement mill parts, brick and clay equipment, excavating machinery, etc.	Stoody Co. and Air Reduction Sales Co., New York
	Stoodite K, Self-Hardening	Hardfacing material—contains Fe, Mo, V, C, Si, Mn	A self-hardening, wear and abrasion-resistant alloy.	Tractor parts, sheepsfoot temper shoes, roll and jaw crushers, gyratory crusher heads, etc.	
	Suttonite and the Suttonizing Process	A hard-metal tool reclaiming rod and process	Combines cutting qualities of high speed steel with abrasion resistance of tungsten carbides. Deposits are grindable, and require no heat treatment.	For reclaiming worn or broken tools, such as milling cutter, broaches, drills, lathe tools, shapers, etc.	Welding Equipment & Supply Co., Detroit
	V-Mang	Alloy steel with 12-14 Mn, some Mo, etc.	Tensile strength and ductility as good as nickel-manganese steel rod; can be as readily applied. Conserves nickel.	Replaces nickel-manganese rod in the reclamation of manganese steel and other ferrous parts by repairing fractures, building-up, etc.	American Manganese Steel Div., Amer. Brake Shoe & Foundry Co., Chicago Heights, Ill.

Type of Material	Trade Name or Designation	Nominal Composition	Outstanding Characteristics	Applications	Manufacturer
Metallurgical Reagents, Addition Alloys, Intensifiers, etc.	Borosil	Ferro-alloy containing B, Si and others	Contributes to increased hardenability of steels with saving of critical alloys	As an addition (reaction agent or intensifier) to wrought and cast steels.	Ohio Ferro-Alloys Corp., Canton, Ohio
	Bortam	Ferro-alloy containing B, Ti and others	Contributes to increased hardenability of steels with saving of critical alloys.	As an addition (reaction agent or intensifier) to wrought and cast steels.	Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
	Ferro-Boron	Ferro-alloy containing B, Si and others	Contributes to increased hardenability of steels with saving of critical alloys.	As an addition (reaction agent or intensifier) to wrought and cast steels.	Molybdenum Corp. of America, Pittsburgh
	Ferro-Boron	Ferro-alloy containing B, Si and others	Contributes to increased hardenability of steels with saving of critical alloys.	As an addition (reaction agent or intensifier) to wrought and cast steels.	Electro-Metallurgical Co., New York
	Foseco Albral	Fluxing agent for copper-aluminum alloys	Removes aluminum oxide from the melt, protects melt from gas absorption, etc.	Improving the casting and physical properties of aluminum bronzes, nickel-base alloys containing aluminum, etc.	Foundry Services, Inc., New York
	Grainal	Ferro-alloy; 20 Ti, 13 Al, 4 Zr, 8 Mn, 0.5 B	Contributes to increased hardenability of steels with saving of critical alloys.	As an addition (reaction agent or intensifier) to wrought and cast steels.	Vanadium Corp. of America, New York
	Silcaz	Ferro-alloy containing Si, Ca, B and others	Contributes to increased hardenability of steels with saving of critical alloys.	As an addition (reaction agent or intensifier) to wrought and cast steels.	Electro-Metallurgical Co., New York

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Non-Metallic Materials (for Design and Construction)	Ameripol (hard)	Synthetic hard rubber	Withstands temperatures 100° F. higher before softening than the best hard rubber made from natural crude.	Molded parts, electrical and radio components, insulators, etc.	B. F. Goodrich Co., Akron, O.
	Dilectene	Synthetic resin (contains no cellulose fillings)	Thermoplastic. Resists temperatures up to 100° F. and 160° F. depending on grade. Red-brown color.	Molded parts for radio, television and aircraft work.	Continental-Diamond Fibre Co., Newark, Del.
	Durez Nos. 11540, 11863 and 11934	Phenol formaldehyde plastics	No. 11540 has all-'round, general-purpose properties; No. 11863 has low power factor; No. 11934 has high impact strength.	No. 11540 used for general-purpose molded parts, No. 11863 for electrical and insulating applications, and No. 11934 for heavy-duty industrial uses.	Durez Plastics & Chemicals, Inc., N. Tonowanda, N. Y.
	Koroseal Sheet	Plasticized vinyl polymer	Resistant to most inorganic acids and salts, to alkalies, and to some organic acids and solvents.	Lining for steel, wood or concrete tanks for pickling, plating, acid storage, etc.	B. F. Goodrich Co., Akron, O.
	Linde Corundum	Synthetic white sapphire (crystallized Al_2O_3)	Flawlessness, high hardness, uniformity.	Bearings and jewels for precision instruments.	Linde Air Products Co., New York
	Plaskon Melamine	Plastic molding compound	Low moisture absorption, good resistance to acids and alkalies, high dielectric strength, and extreme heat resistance.	Available in one plasticity grade. For molded parts to serve in wet or damp environments, in dielectric applications, etc.	Plaskon Co., Inc., Toledo, O.
	Prestite	Compression-molded "porcelain"	Combines best properties of industrial glasses and molded plastics. Resists most corrosives and high temperatures, and has high dielectric strength.	Molded parts (colored if desired) of precise, intricate shape, such as pump valve seats, blast nozzles, etc.	Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
	Pyrex Precision-Bore Tubes	Boro-silicate glass tubing	Precision-bore glass tubes having extreme accuracy of shape and bore.	Mechanical parts or flow meter tubes, etc., with cylindrical or odd-shaped bore.	Corning Glass Works, Corning, N. Y.
	Resinox Nos. 6570 6565 6542 6905 6952 7013	Phenol formaldehyde plastics filled respectively with wood flour, flock, fabric, cord, special fabric and mica	All formulated to meet various types of Navy Spec. 17P4. No. 6570 is an all-'round molding compound, meets Type CFG. No. 6565, used for molded parts of medium impact strength, meets Type CFI10. No. 6542, for high impact strength, meets CFI20. No. 6905, for very high impact, meets CFI40. No. 6952 has extraordinarily high impact strength. No. 7013, for molding electrical parts, meets type MFE.		Monsanto Chemical Co., Plastics Div., Springfield, Mass.

Type of Material	Trade Name or Designation	Nature	Outstanding Characteristics	Applications	Manufacturer
Non-Metallic Materials (for Design and Construction)	Saflex B, F and TS	Polyvinyl acetal plastic resins	Thermoplastics, treated however to produce a thermo-setting reaction after curing. Have toughness over wide range of temperatures. Saflex B and F are naturally adhesive; F resists hydrocarbons; TS resists water and is readily cemented.	Rubber substitutes, for coating fabrics, lining containers and making molded fittings. Can be extruded.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
	Styramic	Filled polystyrene plastic resin	Has higher softening point than polystyrene. Excellent electrical properties. Molded by extrusion, compression or injection.	Tube sockets, coil forms, inductance beads, etc., in communication and electrical devices.	Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Finishes and Coatings	Blackplate Lacquer	Organic coating	Unusual adhesion to black plate. Prevents underfilm corrosion. Available in metallic colors.	Especially useful in conversion from tin plate or terne plate to black plate.	Watson-Standard Co., Pittsburgh
	Dow No. 12	Caustic anodizing process for magnesium	Brilliant, colored, hard, protective coatings produced on magnesium by anodic electrolysis in lithium hydroxide, diethylene glycol solution. Coating may be subsequently dyed.	Magnesium alloy parts that must be corrosion and wear resistant, and which need not be lacquered.	Dow Chemical Co., Midland, Mich.
	Durad	Luminous paint	Glows in the dark without the use of radioactive substances.	For painting objects to be made visible during blackouts.	Maas & Waldstein Co., Newark, N. J.
	Ebonol "C"	Process for chemical blackening of copper alloys with less than 35% Zn	Essentially a black oxide coating. Cannot chip or flake off. Produced by a 2-10 min. immersion in a solution at 200-212° F.	Blackening copper, beryllium copper, bronze, brass, etc. Used on optical equipment, aircraft instruments, detectors, grommets, eyelets, etc.	Enthone Co., New Haven, Conn.
	Griffin's Hytemp	Liquid refractory coating, with mineral ingredients	A heat-resistant coating that forms a porcelain-like glaze at high temperatures. Can be brushed, sprayed or dipped.	For equipment used up to 3500 F., such as refractory brick and tubes in furnaces, kilns, etc.	Geo. R. Mowat Co., New York
	Halogen Tin	Neutral electrotinning process	Faster tin-plating than by "alkaline" method; eliminates sludging and waste of tin. Coating is thinner, more uniform than "hot dip."	Manufacture of tinplate by the electrolytic method.	Electroplating Div., E. I. du Pont de Nemours & Co., Wilmington, Del.
	Johnson Nos. 1568 and 1569	Wax polishes	Rust inhibiting, lustrous, highly protective.	On black-oxidized and Parkerized steel products.	S. C. Johnson & Son, Inc., Racine, Wis.
	Magic-Etch	Chemical bath treatment	Produces a dull-gray matte surface, which obviates blasting. When finished offers a soft black "no-glint" appearance.	As a base for finishes. For no-glint blackening of small arms, bayonets, etc.	Mitchell-Bradford Chemical Co., Bridgeport, Conn.

Type of Material	Trade Name or Designation	Nature	Outstanding Characteristics	Applications	Manufacturer
Finishes and Coatings	Metal Lead Primer	Metallic, lead-type priming paint	Equal in protective value to good aluminum paint. Good adhesion and resistance to marine atmospheres.	Alternative to aluminum paint priming, especially for ship building, aircraft work and shore construction.	Midland Paint & Varnish Co., Cleveland
	Miccroil	Anti-rust oil	A light, transparent, fast-drying (30-45 min.) oil with a high flash point. Applied by hand-dipping.	For placing a protective film on any surface to be guarded against rusting or oxidation—aircraft parts, gages, precision parts, stampings, etc.	Michigan Chrome & Chemical Co., Detroit
	Plastipitch	Pitch-type metal weatherproofing coating	Coating will not become brittle or chip off at low temperatures, nor melt or flow in hot weather.	On all types, forms and gages of metal.	Coated Products Corp., Verona, Pa.
	Proctoil	Anti-rust oil	Water-displacing; used cold. Has high flash point; highly rust-protective.	In place of hot soluble oil following black oxidizing. Protection of highly-finished steel parts during manufacture and storage.	Du-Lite Chemical Corp., Middletown, Conn.
	Protex A-11-20	Rust-inhibitive compound	A cold-dip oil-base rust preventive. Semi-drying waxy coating.	Rust protection of metal parts.	Wayne Chemical Products Co., Detroit
	Protex, HF-QD	Rust preventive	Quick-drying, black protective coating. Has high flash point for safety.	Protective coating for trucks, tanks and other war equipment for export.	
	Rust Veto	Corrosion - inhibiting mineral oil compound	Provides long protection against corrosion without oily feel.	Rust prevention after blackening or Parkerizing of cartridge links and other ordnance parts.	E. F. Houghton & Co., Philadelphia
	Thur-White and Thur-Green	Refractory coatings	Heat-resisting, fire-retarding, durable, adherent paint films. Withstand furnace temperatures.	On hot metal surfaces, to prolong life, for identification, etc.	Thurmalox Co., Doylestown, Pa.
	Tygon F and Tygon G	Synthetic resin coatings	"F" is furfural base; "C" is phenol base. Both are impervious to dilute acids and alkalies and to most solvents. Inert to oils, gasoline, etc.	"F" applied by brush or dip to wood, concrete, metal or fabric; good for tanks and other process equipment. "C" may be brushed, dipped or sprayed on all metals. Both must be heat-set.	United States Stoneware Co., Akron, O.
	Tygon Tempro-Tec	Organic film	Forms a stable, transparent, *non*-adhesive film when dried. Resists oil, grease, gasoline, etc. Can be peeled off as a complete film.	Used during handling, shipping installation, etc. of machine tools, bearing surfaces and metals in many forms.	United States Stoneware Co., Akron, O.
	Vinylite Resin VMCH	Modified vinyl chloride-acetate co-polymer	High adhesion, chemical resistance, water resistance.	Base resin for high quality surface coatings.	Plastics Div., Carbide & Carbon Chemicals Corp., New York

Type of Material	Trade Name or Designation	Nature	Outstanding Characteristics	Applications	Manufacturer
Finishes and Coatings	V-Metalustre	Lacquer	Gives a metallic-lustre finish without the use of metal-powder pigment.	Protective coatings to simulate or replace metal paints.	Maas & Waldstein Co., Newark, N. J.
	Zinc-plated Steel Sheets	Pre-plated strip	Corrosion-resistant, durable, adherent coating. Coated sheets can be formed without subsequent finishing.	Metal stampings, boxes and containers where erosion-resistance is necessary.	American Nickeloid Co., Peru, Ill.
Processing Materials (See also Finishes and Coatings; Welding Rods, Brazing Alloys and Solders; Metallurgical Reagents, Addition Alloys and Intensifiers)	Acrawax C	Synthetic wax (cetyl acetamide)	Replaces unavailable, imported waxes.	For the manufacture of mold lubricants used in powder metallurgy fabrication.	Glyco Products Co., Brooklyn, N. Y.
	Aerocarb Deepcase	Liquid-bath carburizer	A barium-base activated cyanide, featuring chemical stability, rapidity of case penetration and case-uniformity.	Carburization of steel at temperatures of 1700-1750° F. to produce cases up to 0.150 in. deep.	American Cyanamid & Chemical Corp., New York
	Armstrong's Insulating Cement	Cement for insulating firebrick	Made of high-grade refractory clays and grog; expansion coeff. of dried cement similar to that of the brick.	Used for laying insulating firebrick in heating and melting furnaces.	Armstrong Cork Co., Lancaster, Pa.
	BRB Powdered Lubricant	Drawing compound	Unusual lubricating properties, reduces or eliminates cleaning of parts.	Drawing steel shell cases, and other difficult draws.	Wayne Chemical Products Co., Detroit
	Celite	Filtering material (diatomaceous silica)	Forms a filter cake of microscopically-fine pore structure.	Used in filter systems for clarifying cutting, grinding, washing and cooling oils and emulsions.	Johns-Manville, New York
	Chromalloy	Soldering flux	Meets iodine tests.	For fluxing black iron for soldering.	Colonial Alloys Co., Philadelphia
	Colonial Degreasers	Cyclodiene hydrocarbon solvent degreaser	Non-explosive, 20-min. air-dry; can be force-dried.	Solvent degreasing of metal parts prior to plating, painting, rust-proofing, etc.	Colonial Alloys Co., Philadelphia
		Methanated hydrocarbon solvent	Non-explosive, 1-min. air-dry.		
	Dresinate	Wetting agent for metal-cleaners (sodium resinate)	Dry powders, which when added to alkaline-type metal cleaners, improve their cleaning effectiveness and rinse-off qualities.	By mixing with the dry alkalies during formulation, or by direct addition to made-up cleaning solution. Used in either strong alkaline baths or weak.	Hercules Powder Co., Paper-Makers Chem. Dept., Wilmington, Del.
	Florite Dessicant	Granular drying agent for gases and liquids	Maintains high drying efficiency over long periods. Adsorbs water instantly, will not swell. Stable, non-corrosive, non-poisonous.	For producing bone-dry fuel and heat treating gases like natural gas, carbon dioxide, propane, nitrogen, etc., and other fluids.	Floridin Co., Warren, Pa.

Type of Material	Trade Name or Designation	Nature	Outstanding Characteristics	Applications	Manufacturer
Processing Materials (See also Finishes and Coatings; Welding Rods, Brazing Alloys and Solders; Metallurgical Reagents, Addition Alloys and Intensifiers)	Houghto-Clean	Alkaline powdered cleaner	Cleans aluminum and other alloys efficiently, is readily rinsed off.	For cleaning prior to spot welding.	E. F. Houghton and Co., Philadelphia
	Houghto-Draw	Water-and-oil-soluble drawing compound	Provides longer life for forming and deep drawing dies, and fewer rejects.	Drawing steel cartridge cases.	
	Houghto-Quench	Compounded mineral oil	Faster quenching, rapid wetting out, long-time stability.	For wartime (NE and other) steels requiring rapid quenching rates.	
	Industrial Finish Flash-Off	Non-spatter treatment for welding	Applied along the edges of metal to be welded, this material causes molten particles to "bounce-off" instead of sticking.	Used wherever it is desired to avoid grinding or scraping after welding.	Acme White Lead & Color Wks., Detroit
	Kasil	Flux for welding rods	A potash/silica type binder available in 3 grades of differing molecular ratios. Forms non-blooming films.	For the protection of rods and the scavenging of welds of all types.	Philadelphia Quartz Co. Philadelphia
	Macosol	Water-soluble cleaner concentrate	Neutral concentrate for preparing water - emulsion - type cleaners (10-50% strong) to remove grease, oil, tar, etc. at 160-180° F.	Cleaner for all metals, including aluminum and magnesium. Rustproofing iron and steel.	Macdermid, Inc., Waterbury, Conn.
	Matawan AL	Alkaline cleaner (non-electrolytic) for aluminum and magnesium	Rapid acting. Does not etch work at 160° F. and slower jobs; etches slightly on very fast work above 175° F.	Cleaning aluminum and magnesium sheet and castings.	Hanson - Van Winkle Munning Co., Matawan N. J.
	Metso Anhydrous	Cleaning compound (Na_2SiO_3)	An alkali (anhydrous sodium silicate), compatible with soap, wetting agents, other alkalies. Readily soluble, free-flowing.	As a base for alkaline type cleaners for metals and metal parts.	Philadelphia Quartz Co. Philadelphia
	National No. 1 National No. 2 National No. 3 National No. 22	Welding flux Brazing flux Brazing flux Welding flux	Minimum of noxious fuming, bubbling and boiling; adhere well to hot rods in proper proportions.	No. 1: Welding cast iron. No. 2: Brazing cast iron. No. 3: Brazing brass, bronze, copper, steel and malleable. No. 4: Welding aluminum and its alloys.	National Cylinder Ga Co., Chicago
	Nielco Lab. 1167	Cleaner for aluminum	Rapidly cleans sheet aluminum to a perfect water-shed, without oxidation. Safe to handle.	Especially effective for removing oil, zinc chromate and lacquer from aluminum.	Nielco Labs., Detroit
	Oakite No. 90	Alkaline cleaner	Faster action in dirt and grease removal by anodic degreasing or reverse-current cleaning of cold-rolled steel.	Cleaning steel parts, such as aircraft forgings, control instrument parts, gun mechanisms, before finishing.	Oakite Products, Inc., New York
	Oxweld Nozzle Cleaner	Cleaning compound	Efficiently loosens slag and carbon deposits.	For cleaning oxyacetylene welding and cutting nozzle tip orifices.	Apparatus Div., Unio Carbide & Carbon Corp New York
	Pawling Sulphurized	Sulphurized cutting oil, produced from a castor concentrate	Carries more sulphur than ordinary cutting oils, permits cooler and faster operation. Transparent.	Machining of all metals. Especially effective with high-carbon steels.	Pawling Refining Corp Port Chester, N. Y.

Type of Material	Trade Name or Designation	Nature	Outstanding Characteristics	Applications	Manufacturer
Processing Materials (See also Finishes and Coatings; Welding Rods, Brazing Alloys and Solders; Metallurgical Reagents, Addition Alloys and Intensifiers)	Pennsalt K-7	Cleaner (anhydrous sodium silicate plus additions)	An electrolytic tin-film stripper. At 10-12 oz./gal. of cleaner a 5-min. tin deposit can be defilmed in 1 min.	Developed specifically for electrolytic cleaning and defilming in conjunction with the Bullard-Dunn descaling process.	Pennsalt Cleaner Div., Pennsylvania Salt Mfg. Co., Philadelphia
	Permag No. 266	Metal-cleaning powder	An electrolytic steel cleaner, very low in water content. Long life. Used on low concentrations.	For electrolytic cleaning of steel parts. Only 6-8 oz. per gal. of water is required.	Magnuson Products Corp., Brooklyn, N. Y.
	Polar "K"	Organic solvent	Powerful cleaning action on perspiration, water, oil, dirt, etc.	Superior to alcohol for cleaning steel surfaces.	Curran Corp., Malden, Mass.
	Ruscat	Rustproofing and cleaning solution	Produces a mild etch on metal surfaces, together with an inorganic "anchoring" base for subsequent coatings. Applied by brush or dip.	For preparing metal surfaces before application of corrosion resisting paints, synthetic coatings, etc., and for rustproofing iron or steel.	United States Stoneware Co., Akron, O.
	Silflux	Flux for silver soldering (boron compound)	Low-melting, economical and low-priced.	Used for the silver soldering of steel and non-ferrous metals.	Eutectic Welding Alloys Co., New York
	Solderux Cream	Soldering flux	Resistance to speed under heat.	Soldering difficult joints; especially suited to large masses that must be kept hot for a long time; good for very fine wires and delicate parts.	Mico Instrument Co., Cambridge, Mass.
	Stanicut	Cutting oil	Petroleum oil with special additions. Improves tool life and finish.	As a coolant in various machining operations.	Standard Oil Co. (Indiana), Chicago
	Stanicool	Soluble cutting oil	Contains emulsifying agent. Gives additional protection of tool and better finish than conventional soluble oil.		
	Surbrite	Organic pickling inhibitor and brightener	Conserves metal and acid in pickling solutions. Gives a bright finish while allowing efficient removal of oxides.	Continuous pickling of steel, hot or cold; pickling primer to plating, painting, etc.	Hanson - Van Winkle - Munning Co., Matawan, N. J.
	Taylor T-20, T-23 and T-26	Insulating fire brick	Refractory insulating fire brick with maximum service temperatures, *viz:* T-20, 2000 F.; T-23, 2300 F.; T-26, 2600 F.	For industrial furnaces of all types.	Chas. Taylor Sons Co., Cincinnati
	Tempilstik°	Temperature-indicating sticks	Each stick has a specified melting point (from 125 to 1600° F.). "Chalk-mark" made by each stick will melt at and above its specified temperature.	Used (particularly in black-heat range) to "signal" desired preheating temperatures for welding, stress-relief temperatures, etc.	Tempil Corp., New York
	X Industrial Concentrate	Liquid soldering flux	A liquid flux with powerful cleaning ability. Will not injure or discolor the base metal.	For soldering stainless steel, Monel, copper alloys and other special materials (except aluminum), in the making of helmets, submarine controls, chemical tanks, gun parts, etc.	Industrial Service Labs., Milwaukee, Wis.

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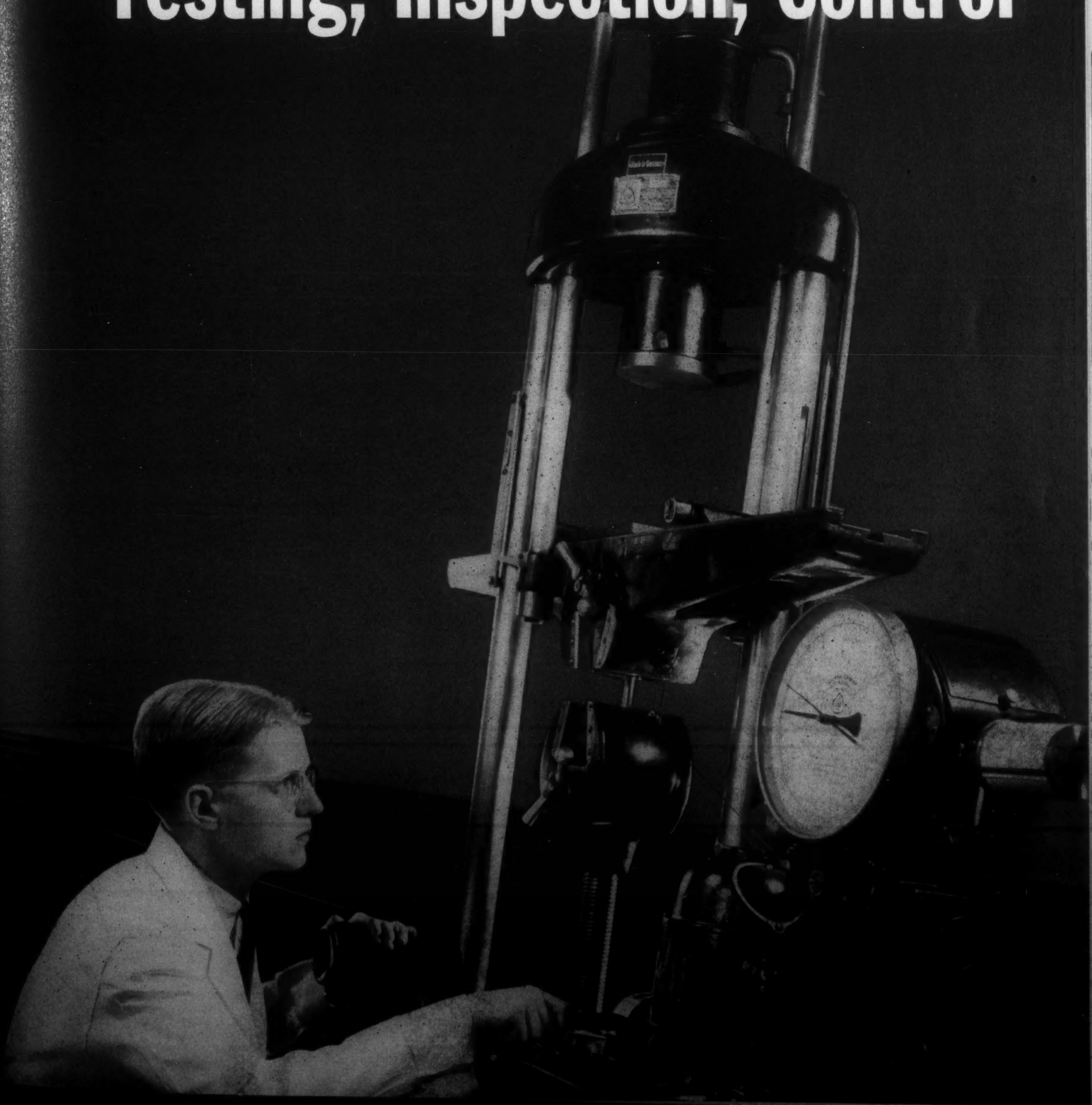
Testing, Inspection, Control



Ordnance Inspection

by John J. Target

Chief, Inspection Section,
Ammunition Branch,
Philadelphia Ordnance District

In order to insure the proper functioning of ammunition issued to the various Field Services, it is necessary to establish a controlled system of inspection in each of the manufacturing plants. Shortly after the last war (May 18, 1922) the office of the Chief of Ordnance organized a system of decentralized ordnance procurement control — later known as Ordnance Districts. These districts now number 13, and are located in the most important cities of the United States. One of the chief purposes of the district system is inspection.

Quality Control

In the early stages of World War II, Ordnance inspection procedures closely followed that of the manufacturers. This resulted in Ordnance inspectors performing duplicate operations to those of a contractor, resulting in a loss of time, delays in production and actually a loss of control of quality. It is pointed out that the high percentage of Ordnance inspection originally made was based on manufacturing experience, since it was originally deemed essential that each and every operation should be checked after being performed.

It was not long before it developed that control of quality of ammunition did not mean more inspection, but actually less inspection under proper control. Thus, quality control was born into the Ordnance Department, so that today quality control systems are being organized throughout the districts.

Quality control lends itself to ammunition production and inspection particularly well, because of the huge quantities of ammunition that are produced every hour of the day. Through well organized quality control, production is kept at its peak and the quality of the product is equally high. The inspection of ammunition bears a responsibility that should be kept in the minds of contractors and inspectors alike. Ammunition, such as shells, bombs, fuzes, shot, etc., is only used once; that is upon firing. A shell must likewise be safe for handling by our own troops.

The successful performance of each unit of ammunition depends upon the design of ordnance engineering, based on former ballistic experience and the ability of a contractor to produce in accordance with the requirements established by this experience. Quality control, therefore, has been required to assume a new responsibility unique to ammunition.

The need for control of quality arises from the fact that, regardless of the efforts expended, some variation of product will exist. Great variations are naturally expensive, but being large can readily be detected and corrected. On the other hand, quality control tends to sort out all defects in a product, thereby directing attention to each and every defect resulting in its elimination.

Sampling Inspection

The most economical, and likewise effective method, is by sampling inspection where only a small percentage of the material is actually inspected. Each cause for rejection on a "go" and "no go" basis is noted and recorded in graph form, which shows at a glance exactly the number of rejects for each dimension involved. In order to properly apply sampling inspection, the manufacturing processes and inspection procedures must be examined to determine the ability to perform and the extent of past control of quality. This will be indicated by percentages of rejections by Ordnance as well as contractor inspectors. Complaints originating from loading plants, proving grounds and field service should also be considered.

Since ammunition is controlled by lots, likewise lots should be selected for sampling, each lot containing units of like manufacture made on the same production line during the same course of time. Samples should be taken from different parts of a given lot so that it will represent as great a cross section picture as is possible. It is important that standardized acceptances be agreed upon so that complete agreement can be had on such factors as surface finishes, snug fits, etc. that do not lend themselves to gage or micrometer checking.

All inspectors should be able to come to the same conclusion. This point is important as its failure would destroy the purpose of the plan; *i.e.,* to have all factors equal so that the ultimate answers will be correct. In order to establish a quality limit on material being shipped, it is necessary to determine the exact requirements of the field. In ammunition these requirements are most rigid. This limit, having been established, will be assured over a long period of time by the sampling plan.

Having developed the above facts a percentage of rejects is established, which percentage shall never be exceeded. Immediately upon detecting a tendency to exceed the limit, the contractor is notified with an immediate follow-up to insure correction. In this manner, the particular operator or machine that is causing the rejection, is corrected and the trouble ceases. The Ordnance inspector foretells trouble as by observation of his records he is easily able to notice a trend toward a failure. Prompt reporting results in early correction and consequent savings in time and money.

Mechanical Testing

by R. L. Templin

Assistant Director of Research and Chief Engineer,
Aluminum Co. of America

The conversion of industries concerned with fabricating metal products to meet the needs of war has had a marked effect on the mechanical testing of metal products. While some producers have been accustomed to making many routine mechanical property inspection tests on their rolled, drawn, forged, cast and extruded products, yet many fabricators of items for military use made from these products have found it advisable, if not mandatory, to make mechanical property tests to an extent much beyond their previous practice.

This is particularly evident in the case of some of the plants that formerly made auto parts but are now making airplanes or sub-assemblies. Nearly all the metal product suppliers, irrespective of the amount of mechanical testing they did previously, have had to increase appreciably the volume of their testing in order to meet Government requirements and the increased volume of production.

Since most of the metal products have been made for military purposes, it has been necessary to test them in accordance with Government specifications. The result has been a standardization of testing methods and procedures throughout industry to an extent never achieved previously. Undoubtedly this standardization will be further extended as the all-out for war effort grows.

Yield and Tensile Testing

During the past year there has been a marked increase in the use of yield strength in metal product inspection. Certain types of steel forgings and castings are now required to meet specified minimum yield strengths whereas before, tensile strength and elongation, or simply hardness, were the only mechanical properties determined.

Modern testing machines equipped with autographic stress-strain recorders have done much to reduce the personal equation and time involved in making tensile tests of metals. For example, one sheet mill laboratory is making more than 13,000 tensile tests per week using six testing machines equipped with autographic recorders, and a testing staff of about 40 persons working in multiple shifts.

The tensile test has been found to be very useful in controlling spot-welding techniques. To facilitate the use of the test in such control work, new testing machines have been developed which are portable or semi-portable and can be readily manipulated by the spot-welding operator. When these testing machines are used near the spot-welding machines, better control of the welding can be maintained and much time saved.

Improvements in Mechanical Tests

A review of published technical papers of the past year shows evidence of considerable research work having been done on mechanical tests for the purpose of developing closer correlation between these tests and the behavior of metal products, particularly sheet metals, when subjected to various types of forming operations. The efforts of the research group of the Lockheed Aircraft Corporation in this field of endeavor are noteworthy. Their results indicate that a modification of the tensile test procedure using very short gage lengths in the elongation determinations and a modification of the drawn-wedge tensile test give useful data in checking the workability of sheet metals. Investigators at Massachusetts Institute of Technology also have suggested modification of the usual type of tensile test so as to give more useful data than obtained in the common specification inspection method of test.

Recognition was given by the American Welding Society during the past year to a new form of bend

Battery of rotating beam fatigue machines. (Courtesy: Aluminum Co. of America)

test for measuring the weldability of steels when fillet welded into structural designs. This test is essentially of the guided bend type involving the use of a special jig and tee-shaped specimen. The U. S. Bureau of Ships has found that the test gives useful information concerning welding quality of steel for ship construction.

More Interest in Fatigue Tests

The interest in fatigue properties of metals has increased considerably during the past year. The designers of military machines appear to be more concerned with fatigue strengths for relatively low numbers of stress-cycles rather than an endurance or fatigue limit based on a very long service life. Increased interest has been shown also in fatigue strengths where stress-raisers are involved, where high and low temperatures obtain, where various chemical or electro-chemical conditions must be withstood, or where combinations of these factors must be considered. These problems have required amplification and modification of fatigue tests and test procedures.

Many of the newer metal products have relatively high ratios of yield to tensile or compressive strengths. These materials generally are less workable than those with lower ratios. Furthermore, new fabrication methods have been introduced to meet the requirements of mass production of war equipment made from these materials. Production difficulties have emphasized the need for the development of more suitable tests for evaluating the workability of the newer materials in the current uses. Undoubtedly these testing needs will be met but the progress made during the past year must be accelerated and amplified.

Women in Testing Laboratories

In keeping with the tendency in other industrial war work, women have been employed extensively as laboratory technicians and assistants in the mechanical testing laboratories. The number of women employees will undoubtedly increase as more men are required for the armed forces.

It would appear, therefore, that suitable testing equipment and methods are available and effectively in use for determining the mechanical properties indicated in product specifications; *viz.* for inspection as to acceptance or rejection of metal products.

War conditions have effected a general standardization of mechanical testing beyond precedent. There is, however, an expressed desire for modification of present tests or development of new tests that will better evaluate the "workability" or "formability" of these products and permit of a better appraisal of the serviceability of the products under various conditions for a given time.

Practical Metallography

by J. R. Vilella

Research Laboratory, U. S. Steel Corp., Kearny, N. J.

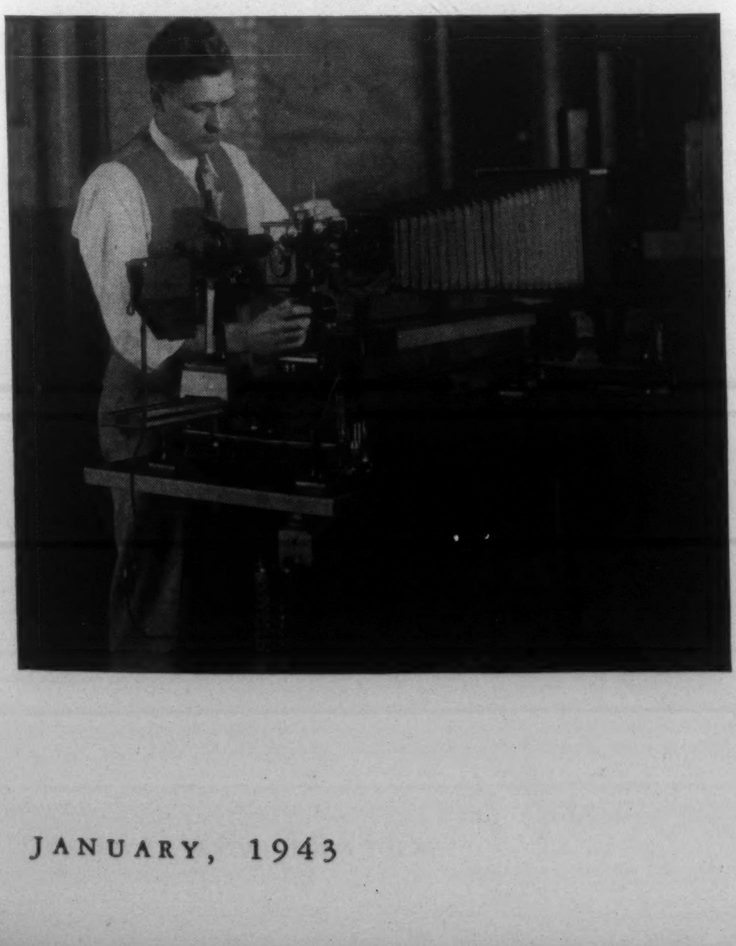
The application to metallographic problems of two comparatively new tools, the electron microscope and electrolytic polishing, may, in the not too distant future, modify our ideas of good metallographic technique, but pending their general introduction in the laboratory, emphasis should continue to be placed on the perfection of existing methods and techniques, with the ultimate goal of better revelation of the microstructure.

Equipment and Technique

Among the recent developments contributing to the attainment of this goal, the following deserves special mention: (1) The use of lead laps in place of grinding paper; (2) the availability at a reasonable price in this country of polishing powder of a quality formerly obtainable only from abroad at practically prohibitive cost; (3) the effort of an organized committee to find, and standardize on, fabric for imparting an adequate final polish; (4) the manufacture in this country of microscopes and objectives comparable in quality with the best, formerly obtainable only from abroad; and (5) the more general effort now made to eliminate disturbed metal from the polished surface prior to examination or photography of the structure.

The electro-polishing of metallographic specimens, now a widely accepted technique in non-ferrous metallography, is destined to become equally useful in the ferrous field, particularly in the preparation of stainless steel specimens, since the main objection, the danger of explosion, has been greatly lessened by the use of a more dilute solution of perchloric acid and by the development of new electrolytes not using this acid. This method, however, has not, as yet, proved to be advantageous in the preparation of specimens of plain carbon or low alloy steels.

A modern metallographic outfit. (Courtesy: Bausch & Lomb Co.)



New Grinding and Polishing Materials

The use of lead laps in place of grinding papers will probably become the accepted method of grinding metallographic specimens because it is rapid, it yields a flat surface, with minimum distortion of the surface metal, with excellent preservation of the non-metallic inclusions, and without heating the specimens to any significant extent. Moreover, it is considerably more economical than grinding with abrasive papers. But we must learn how to eliminate the rather frequent occurrence of deep scratches produced by the finest abrasive; this, the most serious drawback of the method, has deterred some laboratories from adopting it.

To those who actually polish metallographic specimens, the availability of a polishing fabric specially suited for the purpose is an urgent need. Since it is not known exactly why certain fabrics polish better than others, the search for a truly satisfactory material continues by the method of trial and elimination. This procedure, though slow and laborious, has uncovered materials definitely superior to broadcloth, duck, billiard cloth and others still used, but it is highly probable that others are available, far more satisfactory for the purpose than those preferred today but not yet discovered by the metallographer.

In this connection it is of interest to know that recently a new material has been tested with very promising results. It consists of a fabric backing, on the surface of which millions of little fibers are bonded by a special electro-coating process; the fibers are densely packed together, but all in a vertical position and of uniform height. This material polishes rapidly, without scratches, and lasts well.

Domestic Abrasives Now Available

Another comparatively recent development of importance to the metallographer has been the production in this country of abrasives for imparting the final polish, considerably better than the ordinary grade of levigated alumina generally used for the purpose. In the past, the best material available was an imported alumina preparation which had good polishing properties, produced no scratches, and did not form a hard cake on standing. Material at least as good can now be made in any laboratory for a small fraction of the cost of the imported product. In addition, other abrasives, such as excellent grades of magnesia and chromium oxide, are also available.

While the perceptible improvement in the quality of metallographic work from year to year owes much to improved methods and materials, such as those discussed briefly in this review, it owes more to a better understanding of what constitutes good metallographic work. The emphasis today is on the preparation of metallographic specimens free from disturbed metal, so that the structure observed under the microscope is the true structure of the metal and not one modified by improper polishing and etching. In the field of photomicrography the trend is toward faithful reproduction of details and tones at the lowest adequate magnification rather than toward fuzzy pictures of extreme magnification.

Instrumentation

by A. E. Krogh

Engineer in Charge, Application Engineering Div., The Brown Instrument Co., Philadelphia

During the past year, users and manufacturers of industrial instruments have been completely absorbed in the war effort. There has been little opportunity for bringing out new and different instruments but much for applying instruments already available to new and novel purposes.

In furnace work, the use of radiation pyrometers has increased greatly. These devices are frequently able to measure temperatures of furnace work where thermocouples can not, and their freedom from many of the troubles besetting thermocouples has made them highly valued for this type of service as well as for many other applications where thermocouples have heretofore been the accepted standard. During 1942, the art of radiation pyrometry has "grown up." Such units are particularly valued in the heat treatment of armor plate, gun forgings, shell and torpedo casings, and the many other forms of armament in the use of which our enemies are now getting a post-graduate course.

Electronic Instruments Widely Used

The electronic measuring and control instruments brought out before the war have found much acceptance, and all makers have been under heavy demand to produce beyond previously conceived standards of production capacity. The ability of these devices to withstand vibration and other severe service conditions combined with their high sensitivity and speed of response, so useful in control work, has been largely responsible for this development, which, although it appeared to be eventually inevitable, would certainly have been less pronounced had not the war forced it.

It is not permissible to divulge what specific work has been and is being done in further development along this line in connection with the many Government projects, nor are all the facts known to any one individual or Bureau, but much is happening which will enable the instrument maker to keep up with the metallurgical advances that are also being made behind closed doors.

Automatic and Program Control

The science of automatic control has made great strides. The saving of trained manpower possible with such control systems has required their application on many processes where they were formerly considered somewhat in the nature of luxuries, but many of the problems presented by the armament program have also been solvable only because automatic control was available. Fortunately, the increased sensitivity obtainable with electronic instruments has made it possible to do this without complicating the controls themselves and, in fact, it has been possible to simplify many control systems by this virtue.

Program control systems, i.e., systems in which the temperature is made to vary according to prescribed metallurgical programs, have been much in demand and have become necessary adjuncts to many furnaces handling armament metals.

While this review has largely been concerned with temperature measurement and control, it is not because there have been no similar developments along other lines; rather it is typical of the happenings in all lines of instrumentation.

It seems certain that these developments will have permanent effects that will enable instrument makers to meet efficiently the many demands which will arise as our factories return to peace-time economy.

Radiography

by Don M. McCutcheon

Chemical and Metallurgical Dept.,
Ford Motor Co., Dearborn, Mich.

Industrial applications of radiography have increased recently to such an extent that there are few steel foundries and welding shops not directly affected by its use. Numerous specifications, codes and contracts relating to the acceptance of quality castings and welding for aircraft, ordnance or structural use have specified radiographic inspection as part of the requirements.

Producers and manufacturers have available two sources of the radiation used for radiography which can be selected according to their particular requirements. The use of radium has increased almost equally with X-rays as a radiation source particularly with the heavy casting and the welding industry. The convenience and relatively low rental cost of radium is especially attractive to those industries where the advantages in the use of X-ray do not warrant the initial investment required for equipment and special housing facilities.

The Million-Volt X-Ray Unit

New developments in X-ray equipment and accessories can be traced largely to the realization of the suppliers of the growing importance of the industrial applications of radiography. One of the most important recent developments occurred with the introductions of X-ray units in the million volt range. The availability of a million volt X-ray unit commercially, coincided very fortunately with the industrial need for such equipment.

This was particularly true in the welding industry where the heavier sections being welded could be radiographed with a sensitivity not possible with the lower powered X-ray units. Radium is being used successfully for these heavier welds where convenience and portability is required, but the million volt installation is warranted in most cases due to the greatly reduced exposure times obtained with the X-ray unit.

The examination of heavy steel and bronze castings with the million volt X-ray unit has allowed a large increase in the radiographic production due to the elimination of the necessity for blocking. Examination of steel sections up to 5 in. had been possible with lower powered X-ray units provided all irregularly shaped castings were blocked off with X-ray opaque material so that none of the primary X-ray beam could strike the film directly. The elimination of blocking of complicated castings and the large available radiographic field of the million volt unit has resulted in an increased radiographic production of 64 times, in one instance, over former lower voltage procedures.

Testing in the Production Line

Adaptation of production line technique to radiographic testing is a development necessitated by the large volume of parts required for aircraft use. A small lead lined tower housing the X-ray tube is located over an intermittently moving conveyor containing the parts to be radiographed. Entirely automatic operation aside from the assembly and disassembly of the castings allows in excess of 1000 exposures per day. Automatic X-ray film developing machines are required to handle the large numbers of films exposed on the production type X-ray units.

Introduction of new X-ray films especially suited for industrial use has increased the quality of general radiographic inspection. The realization of the advantages of higher film densities, particularly with the new films, has required the introduction of high powered viewing lights. Both photoflood and high intensity fluorescent viewing boxes have been introduced commercially.

Special applications of radiography such as the radiographic examination of aluminum alloy spot welds and microradiography have shown that very small structural details can be observed with X-ray methods. Voltages between 5 k.v. and 30 k.v. required for this work are most efficiently obtained from X-ray tubes equipped with beryllium metal windows. The low X-ray absorption of the beryllium metal windows used on these tubes together with special high contrast grained films produces X-ray images capable of standing considerable magnification.

Improvements in the technical quality of radiographic inspection can be traced to a greater use of the available information on the sensitivity of the radiographic method and the use of either radiographic standard acceptance films or actual static loading of test castings containing known defects, which can be correlated with design stress requirements.

(Editorial continued from page 47)

is ready for promotion in a shorter period.

As to the rank and file of workers themselves, there are several evidences that the supply will prove sufficient. Millions of women will eventually be in the shops, and first experiences with them have been favorable. Rear-Admiral Howard L. Vickery, the spark plug of our shipbuilding program, has told us that in several plants the women welders speeded up the men, the only exception to efficiency being where men gallantly spent time in helping women move equipment.

The half-shift work from 8 p.m. to midnight, done by men who have other work in the day time, will contribute. Moreover, much production is to be slowed down because of too speedy attainment of schedules, decisions to abandon building of certain new plants, and shift of armament manufacture to conform to new strategy on the fighting fronts, all releasing manpower. The exemption of draftees, 38 years old or over, from military service, many of whom are destined for war plants, will prove another source.

Again, transfer of skills from one industry to another in no way related to the first, is perhaps more feasible than generally realized. At mid-October WPB cited "twenty-two more workers in war plants who had been awarded Certificates of Individual Production Merit for suggestions that have increased quantity or quality for war production."

One had been a rabbi, another a musician, while a third had run a chain of news-stands.

—H. A. K.

Heating by Induction

For a long time the principles and applications of high frequency induction heating in both the melting and heat-treating fields have been familiar. Edward F. Northrup blazed the trail when he perfected, after much experimentation and many difficulties, the high frequency melting furnace—today a valuable and widely used unit in producing some of the high grade and complex alloy steels.

Later the use of this type of heating came to its commercial application in heat-treating operations, particularly for the surface hardening of cylindrical shapes—the Tocco process for the outside and the Budd for the inside surfaces. Today this method of heat treatment is not confined solely to cylindrical shapes—unusual products are daily being surface hardened in large quantities by induction.

A new application of this type of heating has lately been developed—the "flowing" or brightening of electrolytically plated tin plate. One of the peculiarities of this plated product is that, when it comes from the plating bath, it is dull gray in color, has irregularities in its surface, is more or less porous and hence more subject to corrosion. By passing this new type of tinplate through a high-frequency inductor, the surface is radically transformed—the tin is fused and evenly flowed on the surface, the somewhat dull appearance is rendered bright, and the product is really brought to a finished condition, ready for the can maker. The speed of this process is one of its chief advantages.

The adoption of the electrolytic tin plating process is spreading rapidly and will soon quite generally displace the older hot dip method. There will therefore be need for a finishing process such as this new development, perfected by Westinghouse, or some other method equally as efficient.

—E. F. C.

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Six dramatic photographs used to illustrate this issue are gratefully accredited herewith:

Cover: Boeing Flying Fortresses in their final production stage — courtesy Ewing Galloway
Facing p. 48: Rolling sheet aluminum — courtesy Aluminum Co. of America
Facing p. 58: Mold for a large casting — courtesy The Warner & Swasey Co.
Facing p. 66: Making a heavy engineering forging — courtesy Allis-Chalmers Mfg. Co.
Facing p. 90: The new M-4 tank — courtesy Office of Emergency Management
Facing p. 114: Making a tensile test — courtesy Jones & Laughlin Steel Corp.

METALLURGICAL ENGINEERING
shop notes

Long Films for Radiography

by Alexander Gobus,
Lucius Pitkin, Inc.

For inspecting welded joints in high pressure steam piping and welds in large pressure vessels, such as heat exchanger shells and general refinery equipment with radium radiography, old techniques were handicapped by the comparative small sizes of individual films to be had, the largest available being 14 in. x 17 in., which were sufficiently large for the medical field from which industry has borrowed the idea.

For the new technique film, companies agreed to supply trial rolls of film, 5 in. wide by 50 ft. long, which the radiographer may cut to desired size. Our experience shows that a practical limit for any one film is 6 ft. long because of inherent difficulties in handling of the lead screen, which, being in three layers, becomes very heavy.

In the earlier processes, some six or eight short films were stapled together to make one long strip. But short lengths must be identified with lead numbers, figures and markers. Matching identification must be stenciled onto the object under inspection. Such technique required much planning before "set-up" to exposure.

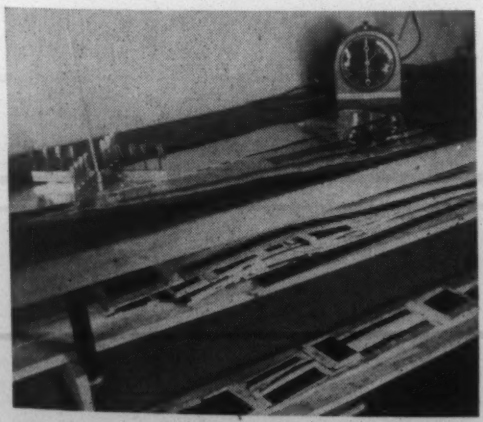


Fig. 1

Great care was needed in locating film ends. Much film was rendered useless because of excessive overlapping at each film end. Processing required a great deal of handling. The final dry film had to be matched up carefully and clipped together. All was slow and cumbersome.

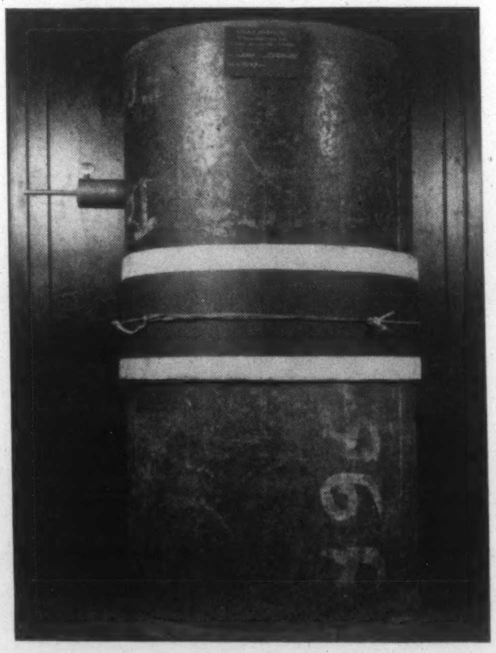


Fig. 2

Of course, with the new process new exposure holders, processing fixtures and screens had to be devised. Ordinary heavy black paper, 36 in. square, was obtained. Where longer holders were needed, paper was joined with rubber cement.

Paper of the desired length was cut 15 in. wide and folded accurately so that two overlapping flaps covered a 5 in. wide receptacle. Edges and sealing areas were covered with adhesive tape. This exposure holder was loaded with tin-coated lead or 6 per cent antimony lead screens, 5 in. wide, in the conventional double-film manner. To stiffen the entire assembly, hard rolled sheet aluminum, 0.008 in. thick, was used, necessary with the soft pure lead, tinned.

The loaded exposure holder was placed around the pipe, which carried such identification figures and penetrameters as desired. Only 2 in. of overlap was necessary against a total of 12 in. by the older method.

A later modification includes the use of 2½ in. wide film where narrow welds are to be inspected. The single long film technique should lend itself in radiography to 1,000,000 volt X-ray apparatus.

The new radium technique was started four years ago, and 5,000 ft. have been used by now — enough to prove its advantages.

In Fig. I, the exposure holder is loaded with lead screens. The holder is held in place by a cord and heavy rubber band in Fig. II. The fixture for holding and centering the radium is in place. (A hole has been drilled 6 in. from the weld center through which the radium is inserted on the fixture.)

In Fig. III appears an old stapled film and one of the improved single films. In the background is part of the viewing box, 15 in. wide and 60 in. long. On the floor are the developing and fixing tank, which are merely enameled steamtable ware for foods.

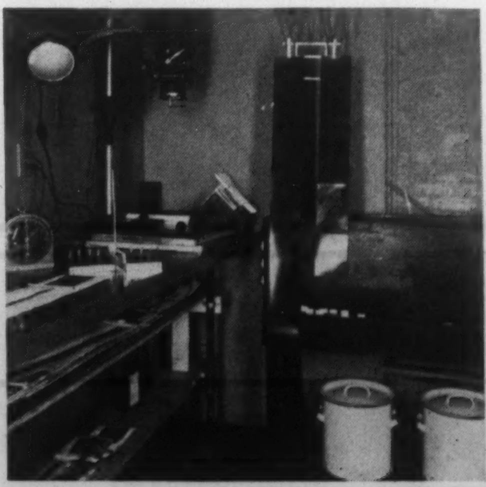


Fig. 3

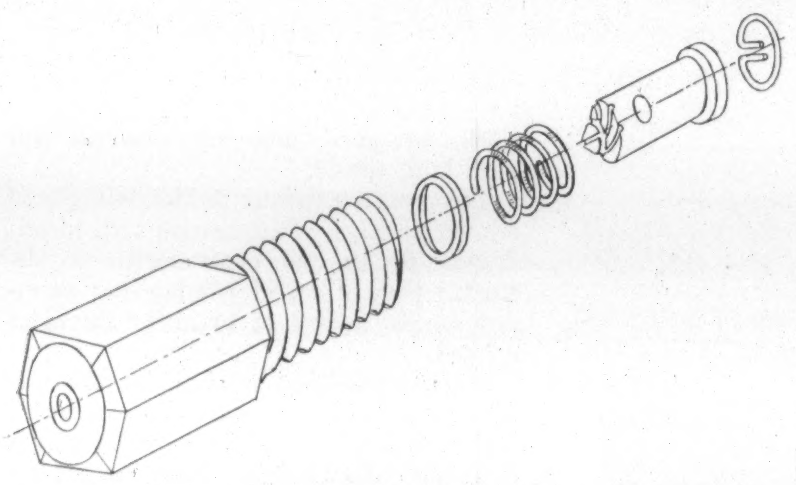
*—**Industrial Radiography***

Self-Cleaning Heat-Treat Nozzle

by James Whitely
Bell Aircraft Corporation

Development of a new type of fog-quenching equipment in the heat treating department at Bell Aircraft Corporation, Buffalo, was accomplished by the designing of an improved self-cleaning nozzle.

In Bell Aircraft's installation, 56 spray nozzles are used on the ceiling of a portable quenching cabinet, which serves two furnaces. These nozzles create a fog spray of water that quenches the aluminum alloy parts for Army P-39 Airacobras as they come out of the heat treating furnaces. This type of heat treating reduces warpage on the parts, and aids in holding oxidation to a minimum. These two factors are important in controlling the amount of hand-forming work necessary after the heat treating is completed.

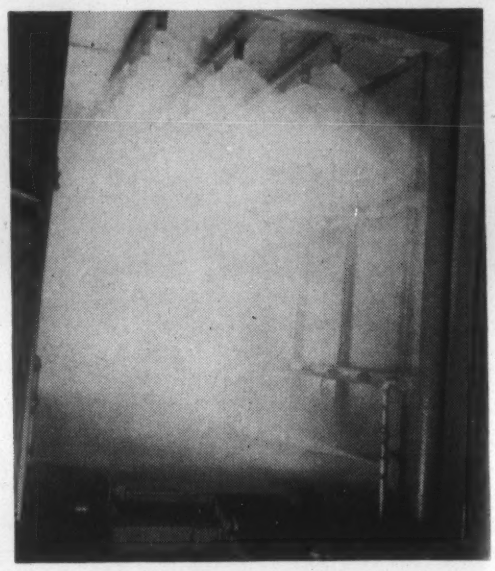


The nozzle was developed to cope with the problem of maintaining a suitable fog quality of the spray, and at the same time prevent minute foreign particles from reducing the efficiency of the nozzle.

It is made in two principal parts: (1) a head which is also a jacket for other parts of the nozzle; and (2) a finger that fits inside and regulates the spray. The finger rests on a spring and also controls the flushing action, which cleans the nozzle automatically before and after each operation.

Under low-water pressure the spring pushes the finger back, enlarging the opening, thus flushing out all small particles. When full pressure develops, the small machined openings at the end of the finger regulates the flow of water with the spring contracted and produces the desired spray. Reduction of the pressure as the water supply is turned off again allows the spring to expand, water, making a solid spray.

All rights on the nozzle are reserved by Bell Aircraft Corporation, but manufacturers in good standing are invited to apply to Bell for use of the idea.



The accompanying photo shows the quenching cabinet used at Bell Aircraft in the heat treating of aluminum alloy parts with the nozzles in action. In the line drawing, reading from left to right, are the parts for the self-cleaning nozzle developed by Bell Aircraft: Nozzle jacket, washer, spring, finger and lock spring.

Copper-Nickel-Antimony for Worm Gears

by Chester B. Hamilton, Jr.
Hamilton Gear & Machine Company

To avoid the use of tin in a bronze because of its critical nature, the Hamilton Gear & Machine Company, Toronto, experimented with other metals and combinations and finally found a combination "really good," better, in fact, than the peace-time bronze. This was a copper-nickel-antimony. The object was to find a metal that, used as a worm gear, would have high load bearing ability, including both strength and resistance to wear, and would operate at a moderate temperature rise. Probably others with similar problems, can reap the benefit of the Hamilton experience.

Trying various percentages of the three metals, antimony between 7 and 8 per cent and nickel between $1\frac{1}{2}$ and $2\frac{1}{2}$ per cent, the balance copper, was found best. Chilling this newer metal showed no improvement, contrary to the experience with Aluminum bronzes, when they fail, damage the previous standard bronze. Accordingly, a plain sand cast gear was used.

The originators have never found it to pit or spall. When it fails, it is by simple abrasive wear of the surface. Again, double the rated pull load, or about 45 per cent of breakdown load, can be applied immediately to a new gear without causing prompt destruction, which is not the case with all gear bronzes. Some good bronzes must be carefully run in with low initial and rising increment loads to cold-work the surface. With the antimony bronze this is not necessary.

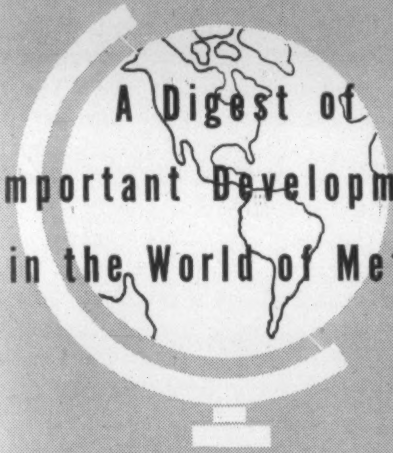
Worm gears of this metal will carry 25 per cent more load than tin bronze, or will run 15 deg. cooler at the same load.

Before the antimony bronze was adopted, other metals were experimented with. the worm. The copper-silicon and copper-silicon-iron groups were a failure. So was copper-nickel-zinc and copper-nickel-lead and several others. The company was moderately successful with copper-nickel-silicon, copper-nickel-silicon-silver and copper-aluminum-antimony, all of which would qualify as "ersatz" materials.

When perforated false bottoms are put in small chip trucks enroute to dumps or to salvage concentration points in a metal-working plant, the machining oil is separated from the metal, dripping into the real bottom, thus aiding salvaging of both the oil and metal. The movement of the truck facilitates the dripping of the oil.

—Edgar Gaston, Cadillac Div., General Motors Corp.

Metallurgical Engineering Digest



A Digest of
Important Developments
in the World of Metals

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1

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5

Specifications. Physical and Mechanical Property Testing and Inspection. Routine Control and Instrumentation. Radiography and Magnetic Inspection, Spectrographic and Photoelastic Analysis. Corrosion- and Wear-Testing. Examination of Coatings. Surface Measurements. Metallographic Inspection and Technique.

1

Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories • Melting and Manufacture of Non Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice

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Triplexing and the Bessemer Converter

Condensed from "Blast Furnace and Steel Plant"

The Bessemer process lost its early hold on the steel industry because of a meager understanding of steel making. It is evident now that high-quality steel for many purposes can be made directly from the Bessemer converter by automatic control of the carbon and fluxing of the metal, and by treatment of the iron with soda ash to reduce the sulphur.

In conjunction with the open-hearth furnace, the Bessemer converter has long been used for duplexing and triplexing, and can serve the electric furnace in the same way. In duplexing, the metallic charge consists entirely of blown metal. In triplexing, some melting is done. The general practice is to charge whatever company scrap is available and to make up the remainder of the charge with blown metal from the converter.

In the early stages of these two processes, the carbon was eliminated to a point too close to the desired amount. Burnt lime and roll scale were used as fluxing agents, resulting in a somewhat inert bath. In some cases, blowing the carbon down too close to that desired caused an over-oxidized condition that could not be corrected because the bath was inert.

High Quality Metal

It has been shown in recent years that a high-quality metal can be produced by the triplexing system by using 3 to 4 per cent raw lime in the fluxing charge and by eliminating 60 to 70 per cent of the carbon instead of 85 to 90 per cent as in the old practice. The raw limestone has a tendency to bring more metal in contact with the slag owing to the increased agitation of the bath when limestone is used. The more active bath may have some bearing on reducing the nitrogen in the blown metal.

The triplexing system is the most economical method of making steel, especially if dry-bottom tilting furnaces are employed. Formerly with this type of furnace, the bottom was never dry, except on weekends, so that the bath was very deep since only a part of the steel was taken out at each tap. This condition aggravated the inertness of the duplexing and triplexing practice at that time.

Tilting vs Stationary Furnaces

Advantages of the dry-bottom tilting furnace over the stationary furnace include (1) 90 per cent less bottom delays; (2) fewer off-composition heats; (3) better slag control; (4) about twice the production of the stationary furnace working on straight scrap heats, 40 per cent iron and 60 per cent scrap heats, or heats using 60 to 80 per cent molten iron; (5) much less fatigue of the furnace crew; (6) less maintenance required; and (7) ladles can be filled one at a time by tilting the furnace back and placing a second ladle under the spout.

A plant now using all dry-bottom tilting furnaces, employing the triplexing system, taps approximately 140-ton heats, with individual furnaces reaching 28 net tons per

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"We got a big Pincers Movement right here: hundreds of tons riding along on a film of oil no thicker than this sheet of paper!

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R-108

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hr. The cost of the converting plant is less than 80 cents per ton of ingots produced.

High Total Yield

Total yield, including converter loss, averages about 90 per cent. Compared with the best and largest stationary furnaces, the increased production from the triplexing method reduces the full cost alone to about 60 per cent of the converting cost.

The cost of constructing a tilting furnace is about 40 per cent greater than for the stationary type. However, because of the increased production, the cost above materials will be reduced more than 65 cents per ton of ingots. The increased production also affects labor and rebuilding costs.

The triplexing method eliminates the many delays in charging open-hearth furnaces and the congested condition of charging floors, because considerably less cold materials are charged.

—John O. Griggs, *Blast Furnace & Steel Plant*, Vol. 30, Oct. 1942, pp. 1123-1125, 1130.

Blast Furnace Refractories

Condensed from the "Journal of The American Ceramic Society"

Chemical and mineralogical examination of blast furnace refractory bricks removed at the end of a campaign have revealed much useful information.

The combined action of alkali attack and of disintegration of bricks due to the disposition of carbon operates approximately as follows: The zone of severe disintegration due to carbon develops at 840 to 1020 deg. F., and is wider at the top of the furnace than at the mantle. It is also near the inner face at the top and closer to the shell at the mantle.

As the alkali reaction removes the brick face, the temperature gradient between the working face and shell changes, and the disintegrating zone advances toward the shell. Alkali attack and the advancing disintegrating action therefore proceed simultaneously.

—H. M. Kraner, *J. Amer. Ceramic Soc.*, Vol. 25, July 1942, pp. 311-320.

Conserving Steelmaking Alloys

Condensed from "Welding Journal"

The consumption of aluminum for deoxidation decreased from 0.70 lb. per ton of ingots in 1940 to 0.56 lb. in June 1941, due largely to the use of substitutes like 50 per cent of ferrosilicon, siliconmanganese, Alsifer and titanium.

Conservation of manganese through changes in deoxidation practice, ladle additions and partial furnace deoxidation with ferrosilicon, and the use of spiegel as a substitute for ferromanganese, have decreased the ferromanganese requirements, but these efforts are balanced by the increased tonnages of grades with 0.50 to 100 per cent and higher manganese. A decrease of 1 lb. of manganese per ton of ingots is roughly equivalent to lengthening our manganese reserves by one month.

The situation with respect to tungsten, vanadium and molybdenum still remains critical and strict conservation measures are needed. The industry faces the very real threat of a continuing shortage of iron and steel scrap. The use of iron ore, greater proportions of pig and mill scale has provided a source of metallic iron in the furnace. The skulls buried in slag dumps in the past are now being "mined" and sent back to the furnace as a source of scrap.

The development of the N. E. steels is discussed to show the amount of various alloys recoverable from scrap in the openhearth and electric furnace, and the properties of the N. E. steels are compared.

—Charles M. Parker, *Welding J.*, Vol. 21, Nov. 1942, pp. 747-755.

Lead Melting Kettles

Condensed from "Metal Treatment"

An improved type of valve for melting kettles, so made that it may be directly fitted to the usual symmetrical or bowlshaped kettle, is now available. It is preferable to have the bottom of the kettle reinforced.

Unnecessary labor and time have been wasted by hand ladling. Some years ago kettles were on the market equipped with a valve and spout. However, valves of this kind became clogged as a diminished heat allowed a crust to form. The type of valve, which necessitates a plug screwed down from the top, can interfere with the pigs of lead that have to be charged and limit the size of scrap introduced. Another

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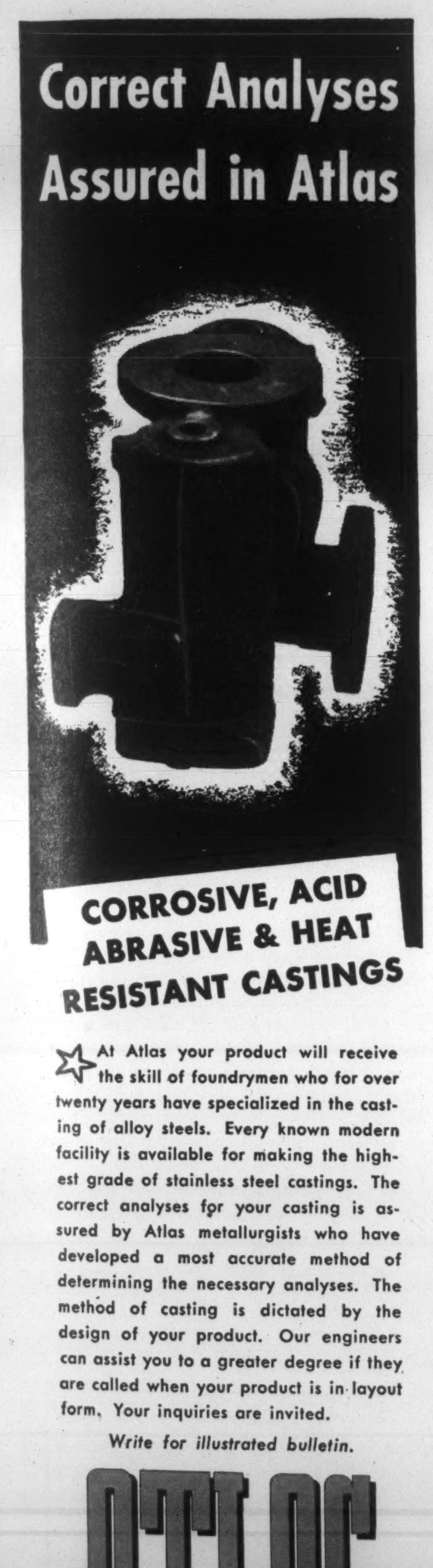

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difficulty was that such kettles had to be specially cast.

In the new type, two valves are used. One is the ordinary working valve and the other an emergency. Both are fitted close to each other by bolted-on flanges. The valve nearest the kettle is always left open, and the flow is directed or manipulated by the working valve. If the metal does not run when the working valve is open, the emergency valve is closed and local heating applied to the former. By then opening both valves the metal flows freely.

If the working valve fails to close during the tapping, the emergency valve is closed, until the threads of the working valve have been cleared. With kettles holding several tons of lead, it is advisable to have an additional spare working valve ready for service. The emergency valve may be closed to allow this replacement at any time.

Both valves are of similar construction. The hand-wheels operating them are constructed on opposite sides of the outlet and a small gas jet is placed between them to minimize any possibility of the lead solidifying. The outlet is a well-rounded bend of mild steel, not an elbow. Asbestos linings are used at the flanges of the valves. The threads should be periodically painted with graphite. The same painting should be applied to the threads of the bolts so that either valve may be quickly disconnected.

Kettles already seated in brick-work foundations may have a circular lug attached to the center of the bottom and a hole bored through the latter to the outlet pipe. Mild steel pipes suffice for general work and are cheaper than the malleable or high-silicon iron used in the kettle.

Present demand for rapid production makes the continued use of direct type melting kettles an anomaly.

—C. C. Downie, *Metal Treatment*, Vol. 9, Autumn 1942, pp. 111-112.

Hot Strip Rolling Mills

Condensed from "Stahl & Eisen" (Translated in Sheet Metal Inds.)

The entire design of the mill is a function of required output, width of strip, and final gage. The disporportionate increase in cost resulting from an increase in width sets an economic limitation on the size of the continuous strip mill. An allowance of 150 to 200 mm. must be added to the maximum width of the finished strip to allow for trimming waste.

The gage of the hot strip is determined by the finished gage required in the cold rolled strip as well as by the amount of cold reduction contemplated. The thicker the final gage rolled, the simpler the design of the hot stands, although a greater ratio of cold reduction may then be needed. Of course, the provision for intermediate annealing during the cold reduction will simplify the hot mill layout, although it will increase the cost of the cold rolling mill.

Recently heavy coils have been less frequently specified and emphasis has been placed on greater gage accuracy obtainable with low coil weights and high rolling speeds. Before pickling the strips are

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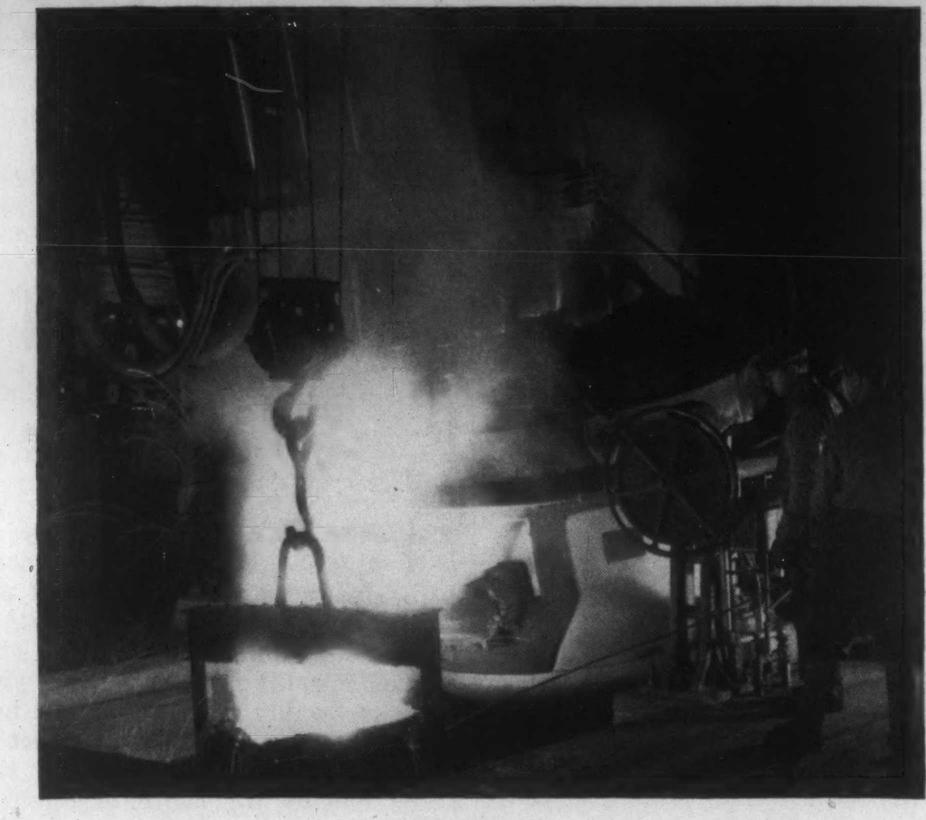

FOR THE *Rapid and Economical Production*

of CARBON AND ALLOY STEELS
GRAY AND MALLEABLE IRONS

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PITTSBURGH, PENNSYLVANIA

welded together to form an endless band and then rolled in two or three parts, preferably on the continuous cold train. A high coil weight is not as important here as in a reversing single stand mill. The author considers that a coil weight of about 650 kg. will prove sufficient

Thickness of the Slab

The slab thickness should be at least 40 to 50 times the final thickness of the wide strip to ensure a high efficiency of working and a good strip surface. The length of the slab used depends on the dimensions of the heating furnace. The thickness of the slab and the final gage determine the number of passes, but there are usually 10 or 11 in modern continuous wide strip mills, not counting descaling passes.

The accuracy of gage of the final strip is determined by the roll adjustment, their spring due to bearing play, etc., expansion of the roll stand, spring of the rolls themselves, state of the roll surfaces, rolling temperature and shape of the material before rolling. A good roughing train is essential to give uniform stock. The greater the rolling pressure, the more the rolls will flex; therefore, it is sought to overcome this disadvantage by limiting the weight of the slab.

Uniform Heat Distribution Necessary

One of the main desiderata is that rolling must be done with as uniform a heat distribution throughout the strip as possible. Stabilization of the heat is achieved by arresting the strip for a short time to permit it to cool to a uniform temperature before entering the finishing stands. Thin strip can be kept at a uniform temperature by means of hot coilers as employed in the Steckel and Röchling mills. [For a description of the latter, see METALS AND ALLOYS, Vol. 16, Sept. 1942, p. 478].

In many cases, a very simple plant of perhaps a single roughing stand followed by a single finishing stand has been designed for rolling hot strip. Medium sheets can be very successfully produced in an arrangement of this kind, but it is suitable for cold rolling strip only if the length of finished strip is made so short that differences in gage are kept within the desired limits. No satisfactory results have been obtained in many attempts to weld together short strips which have been produced on existing hot mills and then to cold roll the long strip to wide sheet.

In planning a wide-strip mill, it seems advisable to aim at a strip of such length that welding becomes unnecessary. It might be investigated whether the expense of additional equipment such as hot coilers is justified, since this does away with the cost of welding units. Suitable arrangements should be made for frequent changing of rolls. Provision should be made in the slab furnace to obtain a dry scale which can be removed by slab breakers and water jets before the slab enters the mill.

Specific mill prototypes are discussed. Comparison is possible only where strip gage, slab thickness, reduction in each pass and rolling speeds are the same. Energy consumption is assessed on the basis of both peak and average values.

Maximum Output per Hour

In calculating the maximum output per hour, actual performance is always much less than theoretical since long intervals are required in the continuous mill to cool the rolls, to equalize the heat before the strip enters the finishing train, etc. Performance per hour is also determined by the number of furnaces and comprehensiveness of adjusting gear.

When the mill is run to capacity and there is a uniform strip sequence, the peak energy consumption values are not much higher than the average consumption. Data are given to show that the substitution of a continuous roughing train for a single reversing stand does not bring any advantage largely owing to the resulting reduction in capacity. The only practical means up to the present for intermediate heating is the hot coiler.

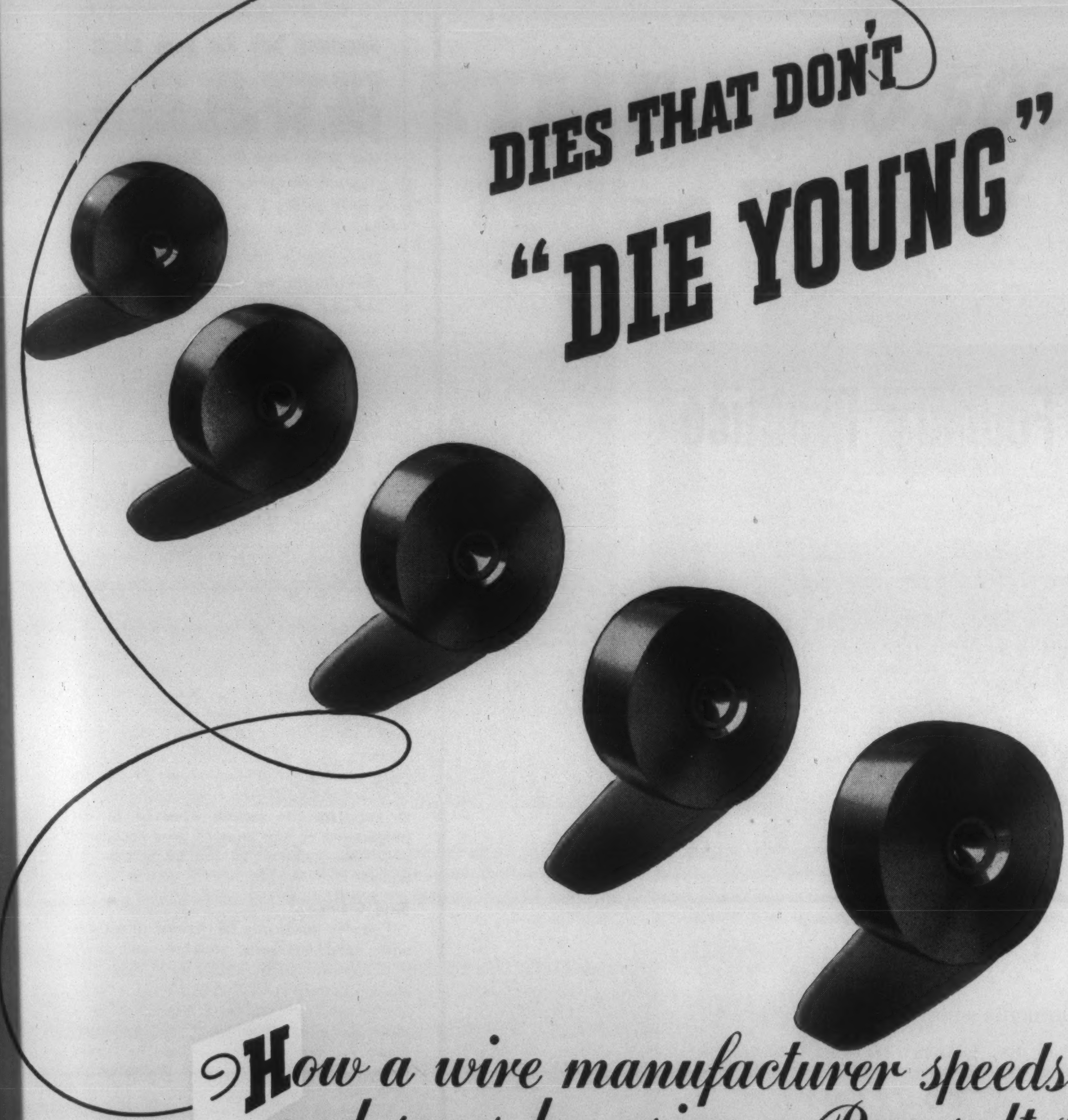
An approximate comparison of the various systems of strip rolling is given in the Table:

—H. P. Lemm, *Stahl und Eisen,* Mar. 26, 1942; Trans. by E. R. Francis, *Sheet Metal Ind.,* Vol. 16, Aug. 1942, pages 1137-1143, Sept. 1942, pages 1316-1318.

Comparison of Hot Strip Rolling Methods

Type of mill	Rating in comparison with continuous mill (which is called 100 per cent)		
	Coil weight	Cap. 1 hr.	1st Cost 1 hr.
Continuous mill with 3 roughers and 6 finishing stands	100	100	100
Semi-continuous mill with 1 rougher and 6 finishing stands	80	70	81
Semi-continuous mill with 1 rougher and 5 finishing stands	60-65	49	74
Single stands, 1 rougher and 1 finisher	15	14	37
Steckel mill, 1 rougher and 1 finisher	100	21	48.5
Röchling mill with 5 finishing stands and a hot coiler after each of the first 3 finishing stands	88	53	71
Röchling mill with 4 finishing stands and hot coilers after each first and second finisher	60-65	35	63
Semi-continuous mill with 5 finishing stands and a hot coiler after the first finisher	70	49	74

DIES THAT DON'T "DIE YOUNG"



How a wire manufacturer speeds outpu and saves by using a Pennsalt Cleane

"Our wire drawing dies aren't lasting as long as they should," decided the production men in a leading steel mill. "And tungsten carbide dies are getting harder to replace, now that expert die makers are scarcer than hen's teeth."

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Something New Has Been Added!

Engineering activity (and the influence of the engineer) in the foundry have become so important that it is high time METALS AND ALLOYS *recognize foundry practice as one of the 4 or 5 broad divisions of the field represented by "engineering in the metal industries." Accordingly, we begin with this issue and on this page the monthly publication of a new section of Metallurgical Engineering Digest, which will cover the engineering problems of producing castings of all types. Digests on melting, pouring and molding of castings and on foundry equipment of all type, formerly included in ection 1, will now appear in this new Section 2.*

—The Editors

Properties of Foundry Sands

Condensed from "The Foundry"

This investigation is the continuation of earlier work, "Some fundamental aspects of foundry sand" [See METALS & ALLOYS, Vol. 14, Oct. 1941, p. 570.] Its main interest is centered about the density of the sand specimen. It is an attempt to correlate the factors involved in the preparation of any rammed sand specimens and their relation to the properties obtained.

Sand Grains

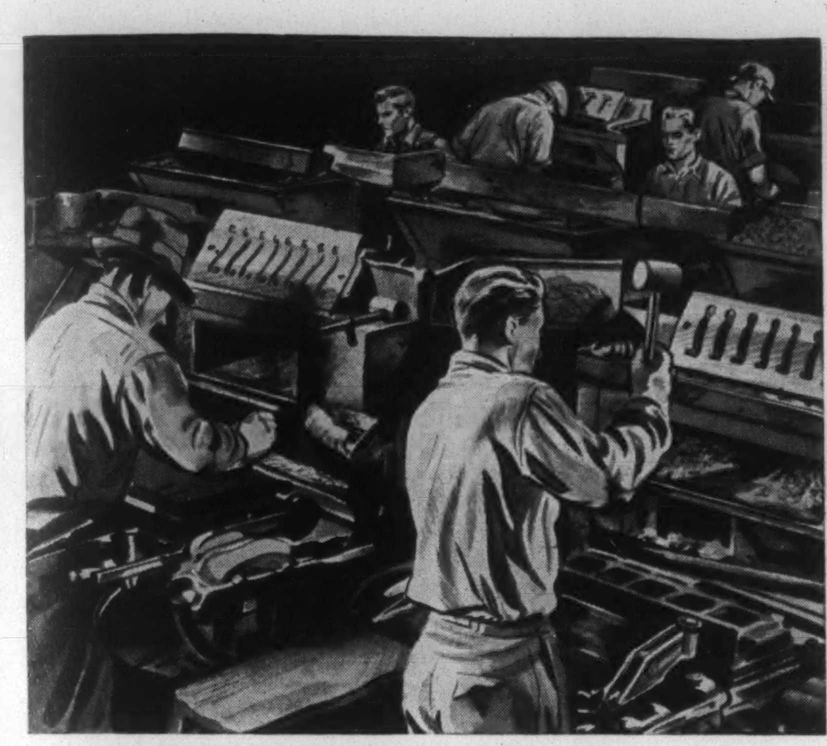
Foundry sands may be divided into sands with imbedded grain structure and sands with contact grain structure. Imbedded grain structure is characteristic for a well-mulled and aerated sand bonded with a pasty or colloidal binder. The individual grains are surrounded by a layer of binder strong enough to keep the grains partly or wholly apart.

Under compression, the sand grains will move with respect to each other under simultaneous flow of the binder which will be squeezed into the intergranular voids. The governing factor in this process is the flowability of the binder. It is important to notice that the flow in this case takes place under decrease in volume of the sand body.

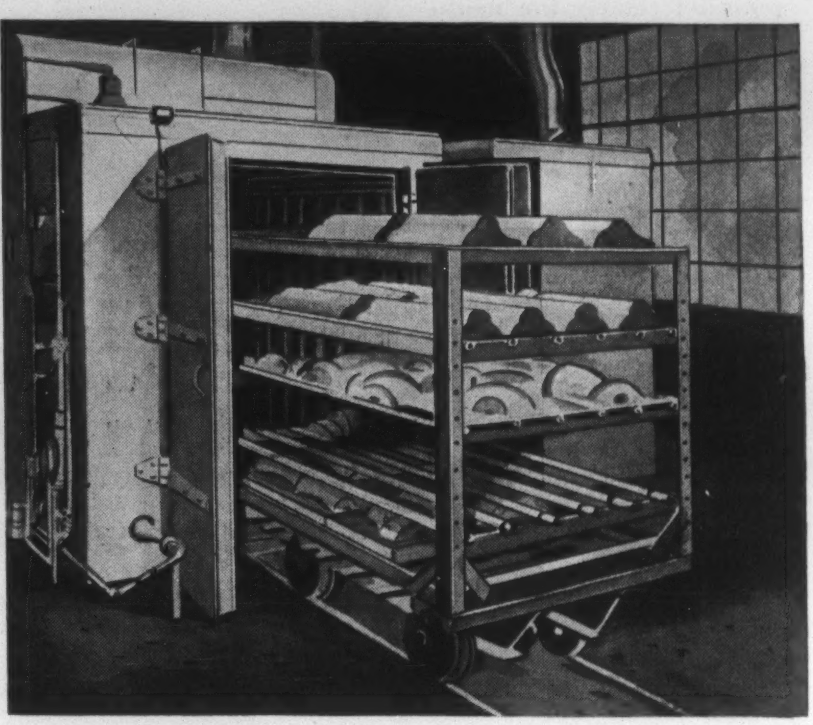
The compression of the sand under ramming, *i.e.*, change from imbedded to contact grain structure, does not take place immediately throughout the sand body. It progresses gradually from the point where ramming is applied. The opposite is true for the imbedded grain structure. Therefore the sand has to be rammed until the process of progressive compression is completed throughout the layer of sand.

Contact grain structure will be found in sands containing oil binders, or in any other types of sand sufficiently and uniformly compressed. The maximum compressibility for a sand of uniform grain size is theoretically 41.5 per cent.

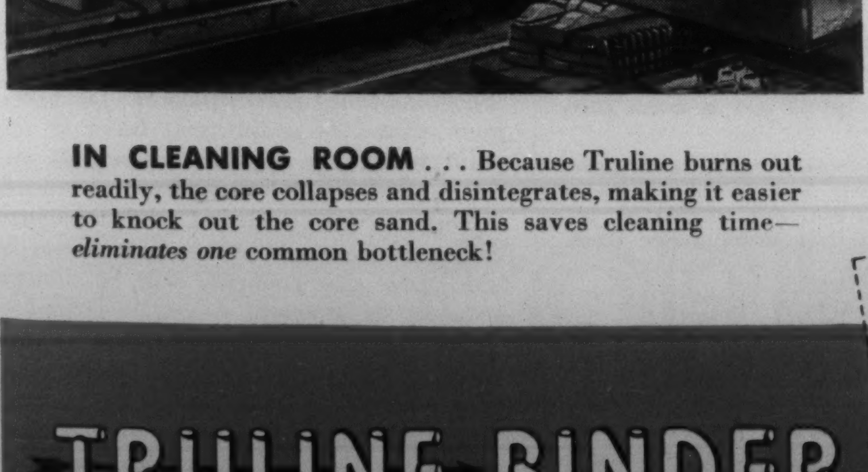
SAVE TIME *up to 50%* with Truline Binder



IN CORE ROOM . . . Truline Binder mixes readily with green, dry, or reclaimed sand. Core mixes flow readily, ram quickly, thus enabling your core makers to turn out *more cores per hour.*



IN BAKE OVEN . . . Because it fuses, then hardens, Truline forms a strong bond at comparatively low temperatures, bakes faster than do slow-baking binders which must be oxidized. *Consequently baking time is sharply cut.*



IN CLEANING ROOM . . . Because Truline burns out readily, the core collapses and disintegrates, making it easier to knock out the core sand. This saves cleaning time—*eliminates one* common bottleneck!

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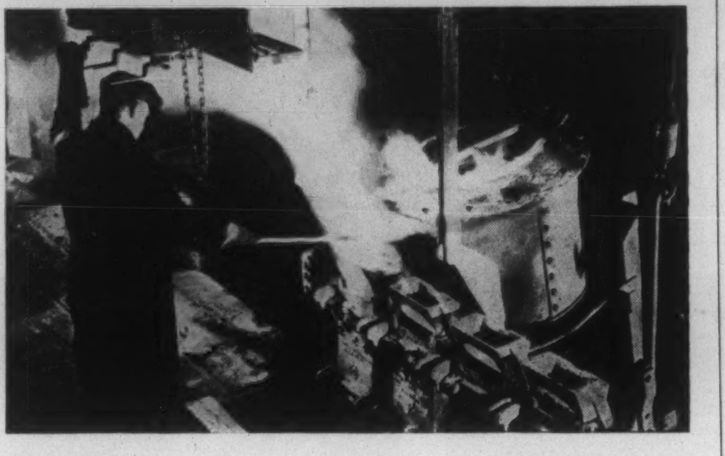

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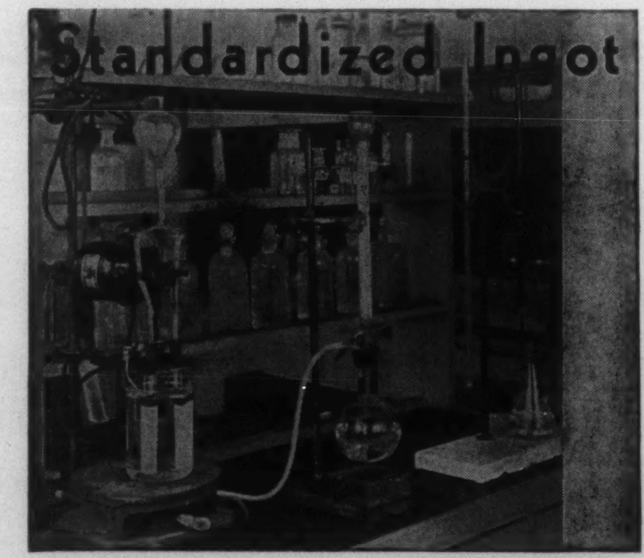

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Its use releases relatively large quantities of tin used in bronze alloys formerly required for such castings.

According to exhaustive laboratory and field reports, this new alloy, known as Ajax "Navy" Tombasil, possesses physical properties far in excess of either Govt. "G" Bronze (88-10-2 and 88-8-4), Spec. 46M6G; or "M" Metal, Spec. 46B8G; as well as the Cu. Si. Alloy known as Spec. 46B28.

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AJAX ELECTRIC COMPANY, INC., Electric Salt Bath Furnaces
AJAX ENGINEERING CORP., Aluminum Melting Induction Furnaces

Experiments on mixes of graded sands show that a certain amount of compression is necessary to get the sand into close-packed condition. When pressure is applied to a sand in the grain contact state, the grains will try to arrange themselves in the closest pack; at the same time, the pressure will be conducted in all directions as in a lightly compressed fluid.

The total value of the sand body is almost constant. A sand pressed into a core box will fill up all the cavities and form a core of uniform structure and hardness. This is the true flowability of sand.

Binders

The binders investigated might be divided into: (1) Low viscosity fluids — oil and oil mixtures; (2) High viscosity fluids — water soluble organic binders; and (3) Colloids — clay binders.

Sand mixtures containing a single fluid binder have no practical applications. In actual practice, linseed oil mixtures always contain some water. Thick core oils generally are made more fluid by the addition of a thinner.

The addition of water or kerosene to linseed oil ought to change the lubricating properties of this liquid as well as other physical properties. Low viscosity binders give a sand with close-packed structure and no decreasing volume flowability.

Physical properties of cereal binders vary within a very small range of water content. Water added to a sand-cereal mixture will increase the strength of the cement surrounding the sand grains very rapidly up to about 1 per cent moisture.

At the critical point, where the imbedded grain structure has reached its highest degree, a maximum decreasing volume flowability can be expected. The more cereal binder added to the sand, the heavier will be the coating around the grains, resulting in lower weight values and lower compression flowability values.

Fairly small variations in the amount of binder produce a remarkable change in the density of the A. F. A. specimen. The same is true for a slight decrease or increase in water content.

Clay and Moisture

True clays form a gelatinous paste or a gel remaining in suspension in thin water dilutions. These actions are due to sorption. They are more pronounced when the clay particles are small.

Water added to a dry mixture of sand and clay will form a pasty binder. This paste clings to the sand grains covering them with a layer of clay, and thus forming an imbedded grain structure. The maximum spread of grains will occur at the point where the clay has reached its optimum swelling and strength.

This is the point of the minimum weight of the sand. When more water is added, the clay gradually will be diluted and lose its strength.

The influence of grain shape is as follows: (1) Weights of sharp sand mixtures are lower than those for round ones. At high clay content, sharp grains can be expected to offer a high resistance to the moving clay, and thus slow down the rate of compression.

(2) The critical points are at practically the same percentage of moisture. This

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means that sharp grains have a greater surface.

(3) The rate of increase in weight of the specimen with increasing moisture is higher for the round sand, probably because the clay moves more freely between the round grains in the imbedded state, and grains themselves move more freely in contact.

Variations in types of clay, amount of moisture and amount of clay changes the density and structure of the A. F. A. test specimen to a considerable degree. These variations effect such properties as permeability and Dietert flowability.

—Erik O. Lissell & Eugene J. Ash, *Foundry*, Vol. 70. Oct. 1942, pp. 78-79, 151-153; Nov. 1942, pp. 80-81, 151-154.

Casting High Speed Steel

Condensed from "The Iron Age"

This article describes a method employed by the Gorham Tool Co. The casting technique makes use of sand or permanent molds for centrifugal casting or for conventional pouring, depending on the size and contour of the parts.

In early tests difficulty was experienced in the selection of a proper mixture of sand and binder in order to eliminate porosity in castings. In attemping to cast several tool blanks at one pouring a number of problems arose. Under such conditions it is necessary to obtain rapid solidification in order to get the desired grain structure, but the solidification has to be very uniform to prevent cracking from strains set up in cooling.

It was the advent of molybdenum steels that stirred the interest because it was apparent that difficulties encountered in casting tungsten steels might be overcome. This was the beginning of molybdenum tools.

To avoid abrasion a small amount of boron is added to this steel. It also gives the steel a resistance to the formation of a decarburized surface and soft skin. The casting process is the most satisfactory method for producing an alloy with a high boron content.

The analysis of this steel is as follows: Mo 8; Cr 4; V 2; Co 8; and B 1 per cent. It is produced in an electric furnace.

Production of tools from this cast steel offers no unusual problems. Castings are annealed for easy machining, making possible the production of complex tools without extensive mold outlay. Blanks are machined by boring, turning, etc. to the desired shape.

Heat-treating schedules have been worked out by which any desired hardness from 60 to 70 Rockwell C can be obtained. The finish grinding and resharpening are carried out on standard equipment. Cutting clearances are the same for cast as for forged steels.

For this material, an unusual red hardness is claimed in addition to wear resistance. It is particularly valuable in cutting operations at speeds well in excess of the speed at which such forged steels break down, and on difficult operations at normal speed where abrasion dulls forged high speed tools.

Certain operations, such as the milling of keyways in axleshafts, are ideal situations for cast tools. This is true since concaves and clearances that are essential to free operation of forged tools can be almost entirely eliminated on cast tools. The principal limitations are in the manufacture of very small or thin tools that are difficult to cast economically.

Cast material is virtually free from hardening distortion. This is important in the production of unground form tools and cutters.

—W. F. Sherman, *Iron Age*, Vol. 150, Sept. 24, 1942, pp. 40-44.

Aluminum Foundry Operations

Condensed from "Automotive and Aviation Industries"

Delco-Remy Division, General Motors Corp. is operating an aluminum foundry supplying parts for airplane engines. Highly mechanized, the mass-production set-up is geared for the economical routing of over 205 different parts and accommodating seven different aluminum alloy specifications.

Quality Factors

The factors in controlling importance in airplane quality aluminum castings are:

1—Control of surface finish. This implies that practically all pinholes, grinding marks, sand cracks, fins etc. must be removed. It means adequate cleaning room facilities and the eliminating of such imperfections in the molding department

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and sand control set-up.

2—Control of internal imperfections. This embraces the elimination of shrinks, blow-holes, dross and cracks. It is achieved by constant watch of foundry procedure and work by the research department.

3—Precise control of physical properties. This involves the following factors:

a. Exacting control of chemistry of the alloys.
b. Close control of pouring temperature.
c. Improved gating and pouring procedures.
d. Constant checking of test bars.
e. Modern heat-treating equipment and precise control.

4—Control of dimensional tolerances. This is concomitant with the lightness demanded of castings that "fly." Major castings are produced in well designed metal fixtures, locating pads are filed and each one closely inspected. Many castings are water tested.

This foundry typifies modernity, as to cleanliness, light, and ventilating. It has its own facilities for making patterns and tools.

Highlights in the technical facilities are: The process of elimination of waste in which all gates, risers, flash, scrap, etc., are suitably prepared and immediately re-used by re-melting; a continuous conveyor serving each furnace; a downdraft ventilation at the shake-out grates, which carries dirt and dust into the pit below.

Immersion in a nitric acid bath, constantly checked by the laboratory, dissolves all iron without affecting the aluminum. Major molding and pouring operations are done on a merry-go-round floor conveyor. In the core department a monorail conveyor carries trays to move finished cores to the baking ovens. A Matthews system of gravity roller conveyors moves flask sections from the shake-out to the molding stations. Cranes transport the heavy flask sections. Post-type boom cranes fitted with Shaw-Box hoists handle core assemblies and small molds.

In addition to the sand foundry operation, a permanent mold department, for making small castings, is in process of expansion. A unique method for producing large castings, with plaster molds instead of sand molding, is about to be translated from experiment to practice.

Melting Equipment

Nose-tilting, gas-fired furnaces with refractory crucibles to prevent contamination of the virgin aluminum alloy, produce about 300 lbs. of metal per hr. at pouring temperature. The height of the pouring ladle, suspended on a monorail, and pushed into pouring position by the operator, is controlled electrically. Direct gas-fired open-hearth furnaces, capable of melting about 2 tons per hr., refine and control the scrap metal. A sample from every batch of 5000 lbs. is analyzed in the laboratory.

Melting temperatures, kept below 1500 deg. F. avoid gas absorption and general oxidation, which would lower physical properties of the metal. Pouring temperatures are kept as low as consistent with necessary fluidity. The only powder fluxing is a chloride-fluoride flux in the direct fired open-hearth furnace. Chlorine gas is occasionally used in the pot furnaces.

Squeezer, jolt roll-over, or jolt squeeze roll-over machines are used depending on the size of the mold. The squeezer machines are arranged in conventional floor style without conveyor. The other two are arranged in a straight line so the copes can be placed on the drags as the drags pass on the conveyor.

As a measure of quality control individual slotted dry sand down sprues, containing a number of narrow slots, provide a positive metering and timing of flow and skim the dross. Each ladle is checked for temperature with a thermocouple type pyrometer. The laboratory has adopted a special type of semi-synthetic sand to provide improved characteristics.

Cleaning and Heat Treatment

In the cleaning rooms there is a closed monorail conveyor line for the preparatory chipping, grinding and snagging. Final touches of filing and polishing are made on benches with Aro portable tools. Castings are cleaned by sand-blasting, shot-blasting or grit-blasting. Inspectors' benches are fitted with fluorescent light sources.

Large castings are heat treated to increase hardness and tensile properties, and improve machinability. Some are simply given an aging treatment to increase surface hardness. Large major castings for the engine structure are permanently identified as to heat treatment and a special serial number.

The Lindberg electric and gas pit type furnaces for solution treatment and aging are rectangular and have air operated tops which swing back vertically. They are of re-circulated hot air design and are individually controlled by recording potentiometer type instruments. Quenching is done in boiling water in 15-ft. deep tanks. Each casting goes to final inspection for Brinell hardness and for dimensional checking.

Cores are made up in International jolt roll-over molding machines or by blowing. Each individual piece is carefully gaged. Assemblies, such as that for the cylinder head, composed of 47 pieces, are made up in massive metal fixtures to assure perfection of size and alignment.

The laboratory provides a complete set-up for the control of the product. The chemical laboratory analyzes 15 to 20 samples of alloy per shift. The spectrographic laboratory allows working space for approximately two men per shift. The physical testing laboratory pulls hundreds of test bars per two shifts. It checks molding sand for moisture, permeability and green compression strength every half hour.

The metallographic and X-ray department, with complete equipment for both micro and macro examination of castings determines quality of heat treatment, pouring temperature, nature of porosity etc. Probably most important is the X-ray, used extensively to analyze the gating for new castings and to determine types of defects.

—Joseph Geschelin, *Automotive and Aviation Industries*, Vol. 87, Nov. 1, 1942, pp. 18-23, 86.

DO *you*
HAVE ANY
OF THESE
melting problems
?

- **Oxidation of Metals?**
- **Absorption of Gases?**
- **Porosity in Castings?**
- **Low Physical Properties?**
- **Elimination of Aluminum Contamination?**
- **Aluminum Oxide removal?**
- **Removal of non-metallic inclusions?**
- **Metal-loss in Drosses or Slags?**
- **Lack of Fluidity?**
- **Pinholes, cracks, draws, etc.**

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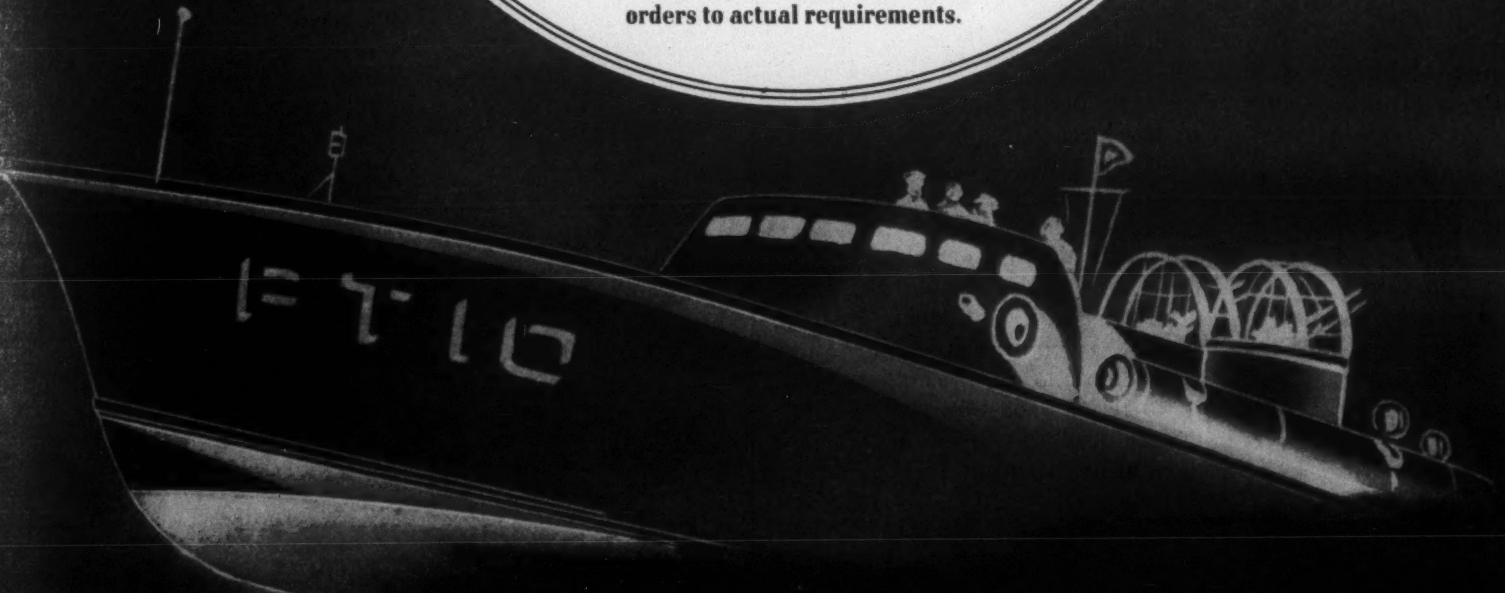

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Forging the "NE" Steels

Condensed from "Heat Treating and Forging"

From experience in forging other steels, it is possible to predict with reasonable accuracy the possibilities and limitations of forging the new NE steels.

Since the NE steels have a lower content of alloying elements than the steels they replace, their forgeability should be improved. Preliminary tests confirm this indication.

Compared with the higher alloyed steels, the NE steels can be used to produce forgings of almost equal strength in most instances and of equal strength in some cases. Their easier forgeability and readier flow to desired shapes in the plastic state permit an increased variety of shapes in forged parts. Often a part can be modified slightly to increase structural strength without increasing size or weight, thus compensating for the decrease in alloy content. Better die life from NE steels permits closer adherance to tolerances and allows longer production runs.

By proper positioning of the fiber structure, strength and wearing qualities can be increased. Correct use of fiber direction has led to production of strong light parts for aircraft motor units, fuselage fittings, and landing-gear forgings. Most of these parts can be designed to use NE steels satisfactorily.

The carbon-molybdenum steels in the A-4000 series contain up to 0.60 per cent Mo and have about the same forging characteristics as do the structural carbon steels of the same carbon content. This series should be considered where a good, easily worked moderate alloy steel is desirable.

The manganese-molybdenum structural steels in the NE 8000 series are similar in forging characteristics to the T-1300 alloy series. They handle readily for all forging operations. Their properties are similar to those of many of the chromium-nickel structural steels, which should make them popular. The manganese tends to improve machinability.

The chromium-nickel-molybdenum structural steels in the NE 8000 series are the strongest NE steels and can be specified for most conditions where extreme service is encountered. With correct handling and under good forging conditions, they can be forged into most shapes.

Proper temperature control and care in handling produce a fine uniform structure. Coupled with careful design and proper fiber direction, parts made from these steels should compare favorably in most cases with those made from the replaced steels.

—Waldemar Naujoks, *Heat Treating & Forging*, Vol. 28, Sept. 1942, pages 460-461, 495, 502.

Drying Coatings by Infra-Red Ray

Condensed from "Products Finishing"

A gas-fired oven is described that combines the features of ordinary convection heated baking ovens with the infra-red method of baking. A pre-mixed gas and air mixture is delivered to the burner and the burning mixture impinges on refractory surfaces which are heated to incandescence and emit infra-red rays. The heat-

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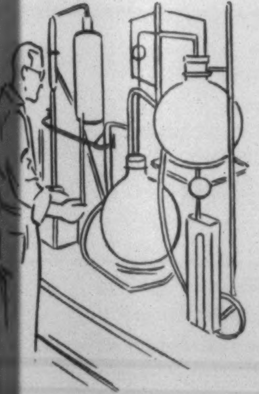

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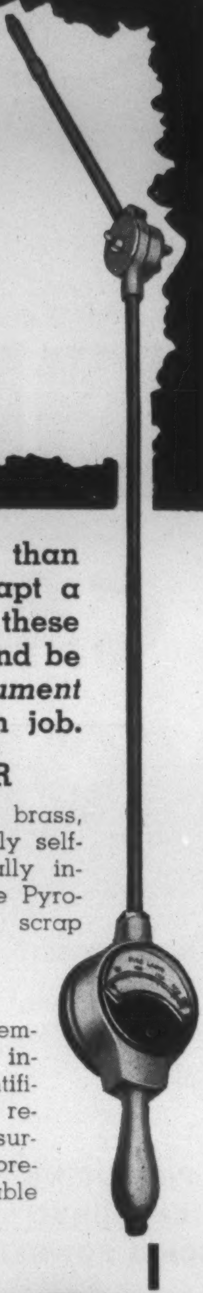

When minutes and metals mean more than money, it is poor economy to try to adapt a "general" tool to a special job . . . Consider these representative items from the Alnor line and be convinced that there is a *specialized instrument* available for YOUR particular production job.

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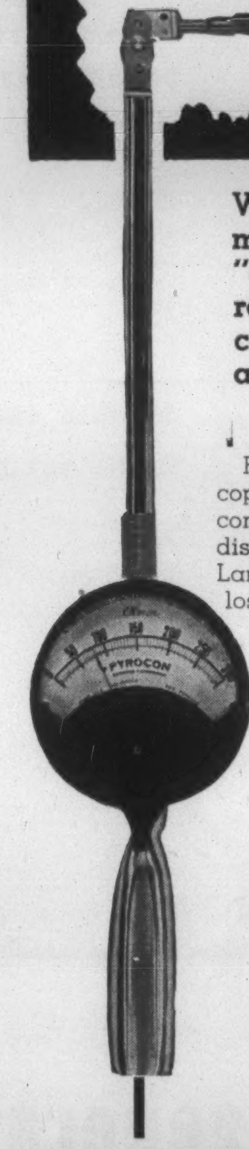
Ruggedly designed for *direct immersion* in molten brass, copper or bronze, the Alnor Pyro-Lance is a completely self-contained and portable instrument which is practically indispensable for the production of sound castings. The Pyro-Lance can help every non-ferrous foundry-man cut scrap losses and reduce fuel wastage.



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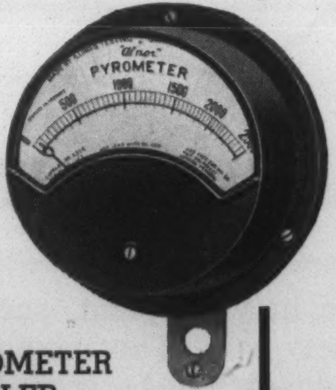

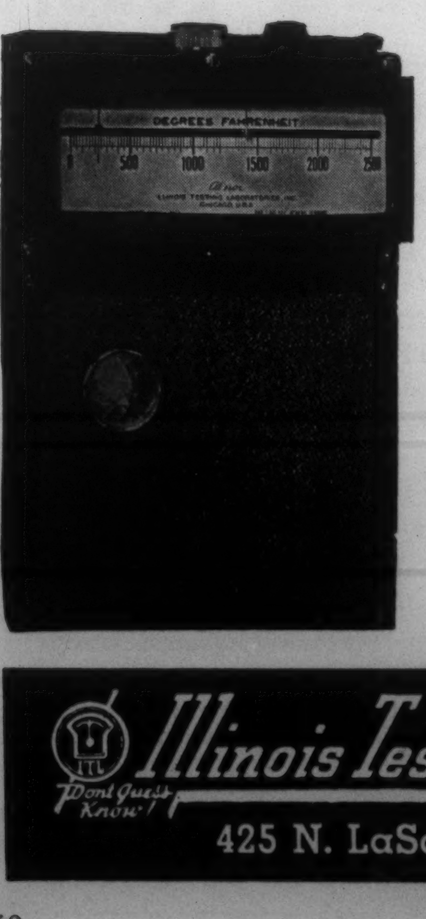

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ing units are adapted to installation in old ovens.

Increased drying speed is one of the chief advantages of this type of oven. Oil base paints formerly requiring 1 hr. to bake are baked in 16 min. A japan finish formerly requiring 1½ hrs. or longer can now be baked in 20 to 25 min. Ovens can be heated rapidly. In an example cited, an oven was heated to 400 deg. F. in 11 min. from a cold start. In tests on speed of heating work, 16 gage metal reached 250 deg. F. in 3½ min. and 270 deg. F. in 5 min., in an oven in which the air temperature was 250 deg. F. The higher metal than air temperature shows the effect of the radiant heat. Other advantages cited are the flexibility and economy of this method of heating.

—Paul H. Gallagher, *Products Finishing*, Vol. 6, Aug. 1942, pages 18-22.

Weld-Repair of Iron Castings

Condensed from "The Foundry"

Low temperature welding is used for reclaiming gray iron castings. It is accomplished with little or no preheating, using a special ferrous alloy rod which is applied with either oxy-acetylene or arc welding. The procedure is to grind or chip off defective portions. This has been satisfactory at least on the surface of sections 3/16 in. thick and over ½ in. square. The part is then slightly preheated for a few minutes depending on the thickness of the part.

During heating a special flux in paste form is applied. As soon as the temperature reaches about 950 deg. F. an alloy rod, Castolin No. 14, is placed in front of the torch. The rod material will flow ahead of the torch without fusion of the parent metal. The alloy forms a good bond with the base metal at temperatures between 950 and 1400 deg.

This method permits reclamation with little or no distortion. It has been found that, with castings of complicated design, preheating could be reduced to 300 to 500 deg. F. or at the highest to 800 deg. F. Machining of the part can be accomplished without difficulty. By selection of the proper rod, the color of the weld can be made to match.

—P. D. Wasserman, *Foundry*, Vol. 70, Oct. 1942, page 127.

Fabricating Tank Armor

Condensed from "Engineer"

Up to 1936 tanks and armored fighting vehicles were of riveted construction, a method which involved the drilling of thousands of holes in hard armor plate accurately machined to size.

There are three possible methods of speeding up production: (1) The use of cast plates and castings for gun turrets, etc.; (2) the use of a fabricated structure made up of welded plates and castings if the latter are necessary; and (3) the welding together of cast assemblies, using "buttered" castings so as to prevent the weld metal causing trouble at the joints.

Although very large steel castings can be successfully made in considerable quantities, adequate heat treatment must be provided to remove stresses set up in the

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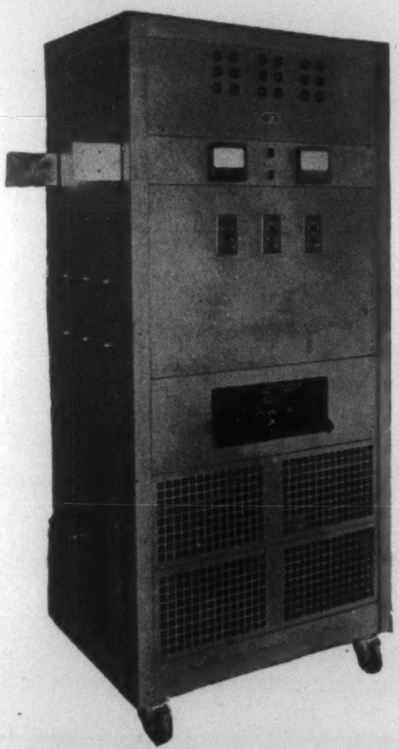

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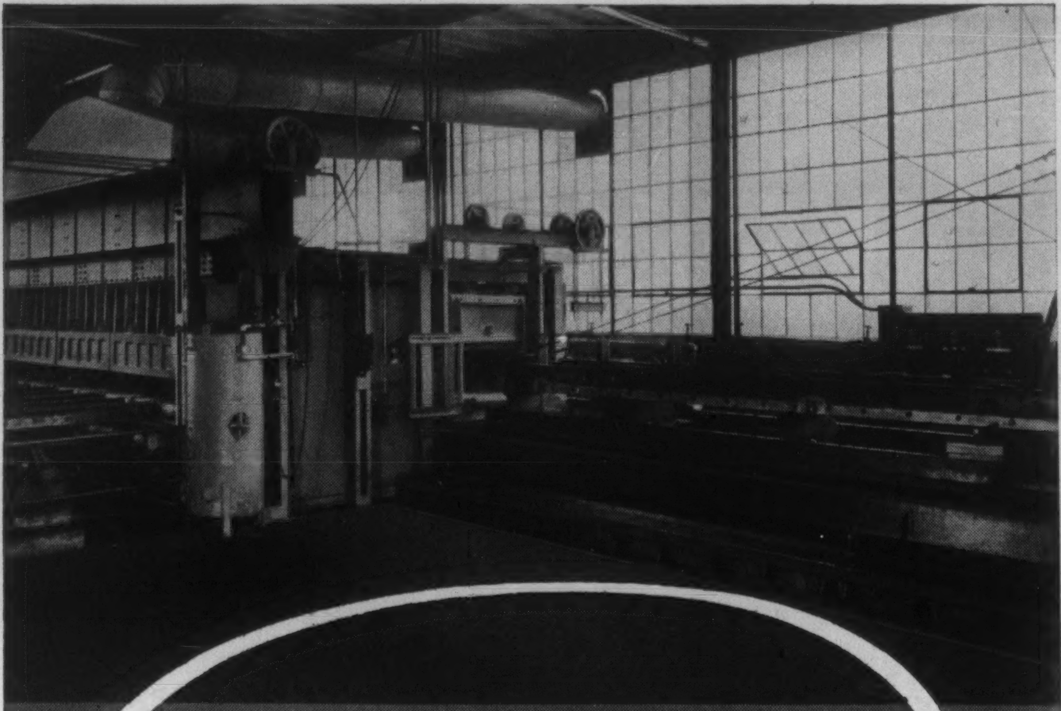

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casting process. After machining, the castings require hardening and tempering in order to produce the requisite bullet-resisting properties, and great care is necessary to prevent distortion.

The second method, using a fabricated structure of both welded plates and castings, has much to recommend it. The third method, the welding together of cast assemblies, is discussed in detail.

The author, who has been connected for many years with the production and machining of armor plate for fighting vehicles, indicates the correct procedure for the gas cutting and welding of bullet-proof plate.

He points out that the welded structure is much more immune to attack, as there are no open joints through which "splash" can occur or the contents of gasoline bombs seep. In a riveted tank the rivets may become a second projectile inside the hull.

In the field, a plate in the structure damaged by attack can be speedily repaired by having the damaged portion removed by flame cutting and welding on a patch plate from stock. A photograph of German welded tanks is reproduced.

—W. E. Woodward, *Engineer*, Mar. 1942, pp. 251-252; abstracted in *Welding Lit. Rev.*, Vol. 4, Aug. 1942, p. 745.

Cast Iron Weld-Rods

Condensed from "Welding Journal"

In the past, cast iron welding has been restricted to the repair of castings and the property of greatest interest was the machinability of the repair. Current specifications for cast iron rods in oxyacetylene welding are 3.00-3.50 and 2.75-3.50 per cent Si. The high side of the silicon range was favored to produce a highly machinable repair.

In the lower part of the total carbon range, at 3.00, and down to 2.50 per cent C a content of 3.00 per cent Si or higher would be necessary to produce a sufficiently low combined carbon for welding purposes. In the upper part of the permissible range, around 3.35 per cent C the minimum silicon content of 2.75 per cent and the commonly used 3.00 per cent (and over) result in a lower combined carbon than required.

Tests made with a rod with a relatively high total carbon of 3.35 per cent and low silicon (2.20%) showed that neither hardness nor machinability were adversely affected. The Brinell hardness of 228 is in exactly the same range as deposits made with a 3.00 per cent Si rod. The tensile strength of approximately 35,000 lbs. per sq. in. is an increase of almost 75 per cent over the cast iron rods in common use today.

The phosphorus content of the low silicon rod is kept to 0.20 per cent maximum as compared to 0.75 per cent in the accepted 3.00 per cent Si rod. The fluidity of the newer rod is considered to be better than that of the high-silicon, high-phosphorus rod.

Combinations of alloys replacing part of the silicon such as molybdenum-nickel, molybdenum-copper, copper-titanium, copper-vanadium and vanadium-titanium have been found to be highly effective in the 2.20 per cent Si range in producing a

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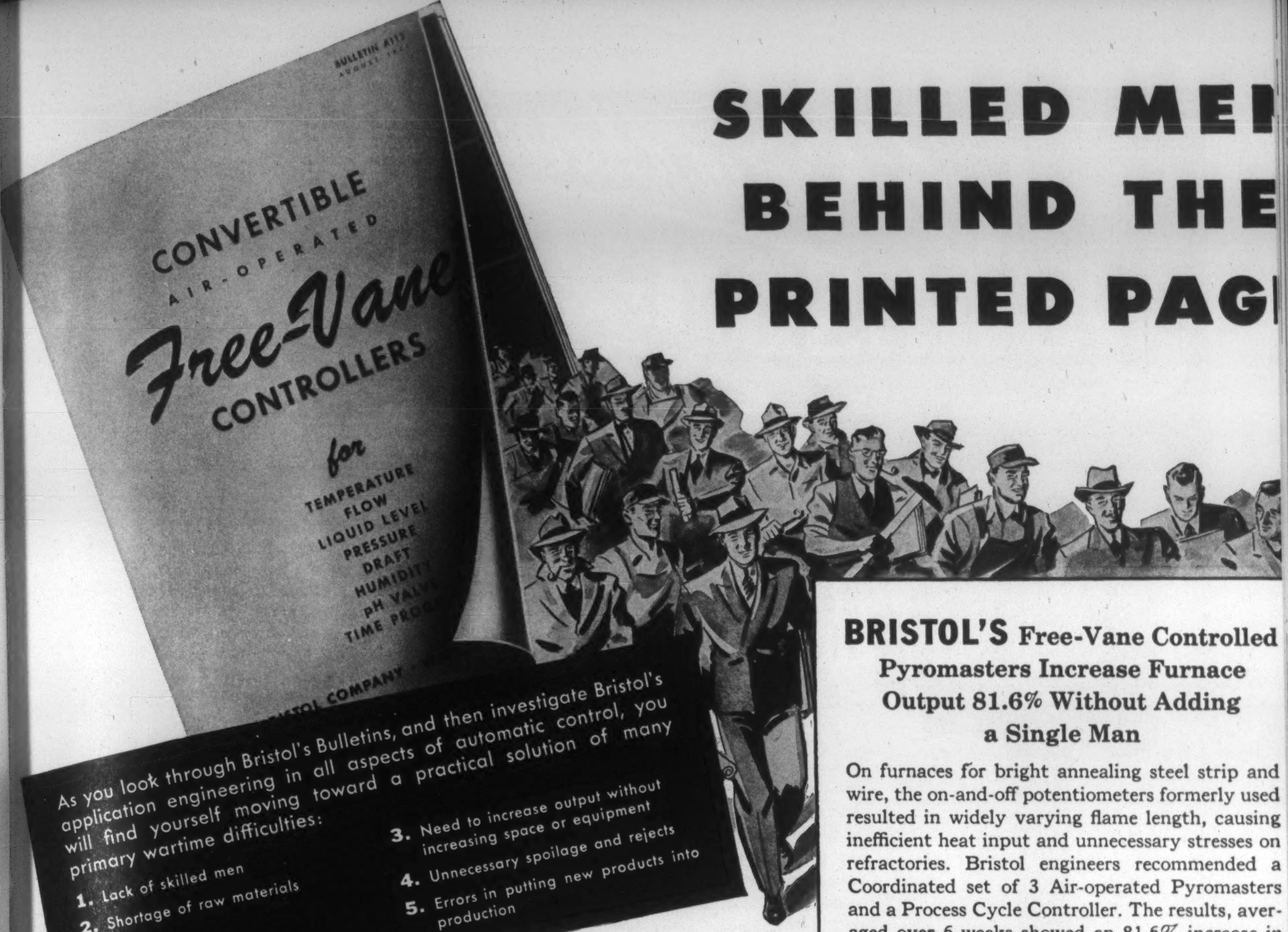

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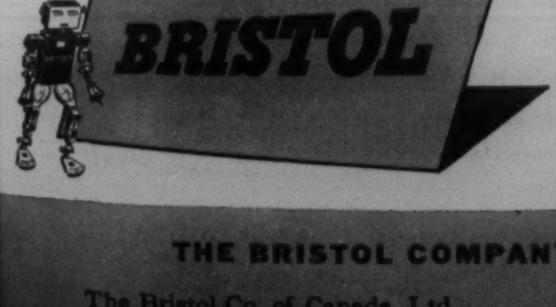

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fine-grained, strong, sound weld deposit. The metals chromium, vanadium, molybdenum and zirconium exhibit the same characteristics as when used in the cupola and when present in the proper quantities in the coating, and are definitely hardening and strengthening agents.

Through their proper use, in combination with conditioning metals, cast iron weld deposits with 50,000 lbs. per sq. in. have been produced completely machinable with 275 Brinell hardness.

—R. V. Franklin, *Welding J.*, Vol. 21, Oct. 1942, pp. 698-699.

Making Aero Exhaust Manifolds

Condensed from "American Machinist"

Aircraft manifolds must be capable of withstanding temperatures from —50 to 1600 deg. F. and also of handling exhaust products under pressures maintained as part of supercharger assembly. After approval by the engineering division, the drawings are sent to the modeling shop where the production methods are worked out. Upon completion, a model representing half the manifold is produced. A shell cast is taken from the model and the other half is constructed upon this with clay.

Standard foundry methods are used for casting the dies, while the punch is cast directly into the die [presumably Kirksite dies and lead punches are used]. The die is cleared to allow for the material thickness of the stampings. Templets are placed on a single sheet which is then sprayed with a marking solution. This sheet is later placed on top of a stack of sheets and used as a pattern for cutting. Although the drop hammer is not ordinarily considered a production tool, it has proven satisfactory in this case for volume production.

Use of Stainless Steel

It was early found that the usual buffed and polished stainless (18-8) was not satisfactory. The extreme smoothness made stamping difficult because the dies were unable to grasp the metal firmly, and as stamping progressed, uniform deformation of the metal would not result. Furthermore, undue annealing and excessive scrap losses resulted. Today the stainless is slightly roughened by a final pickling operation at the steel mills, while a modification of the 18-8 analysis gives increased ductility and greater work hardening before rupture occurs.

The drop hammer stampings are degreased and pickled in HNO_3 (to remove foreign metallic particles picked up in stamping or previous mechanical working) before annealing by an air cool from 1950 deg. F. The parts are then again pickled and inspected before welding. The manifolds are tacked, then welded along the tacked seam by the atomic hydrogen welding process. This process has been found to give a great increase in inches of weld per minute, a more ductile weld and to eliminate the necessity for flux.

The parts are stress relieved after seam welding, sand blasted, trimmed and prepared for assembly. The final welding is electric arc. The finished manifold is sandblasted, inspected, and passivated before shipment.

—E. A. Moore, *Am. Machinist*, Vol. 86, Sept. 3, 1942, pages 959-969.

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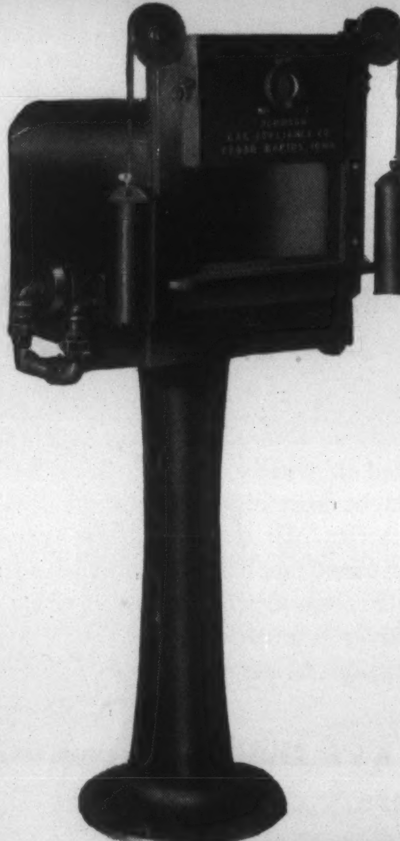

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These Johnson Heat-Treating Furnaces, for hi-speed steel, give high, accurate temperatures.

No. 130, Firebox 5½"x13"x13½" $248.00

No. 120, Firebox 5"x7¾"x13½" $129.50. All Prices F. O. B. Factory

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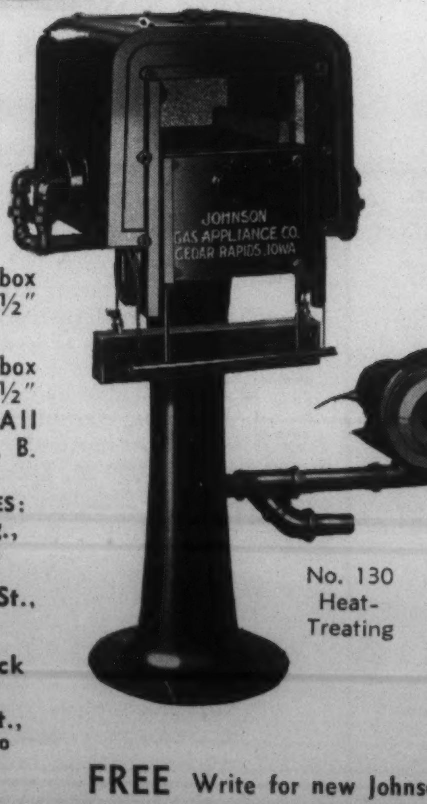
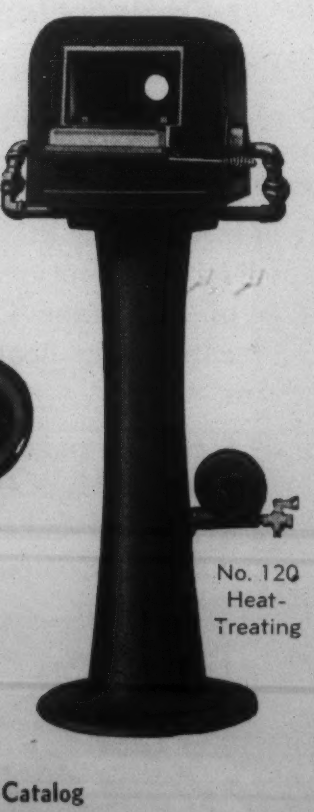


No. 130 Heat-Treating



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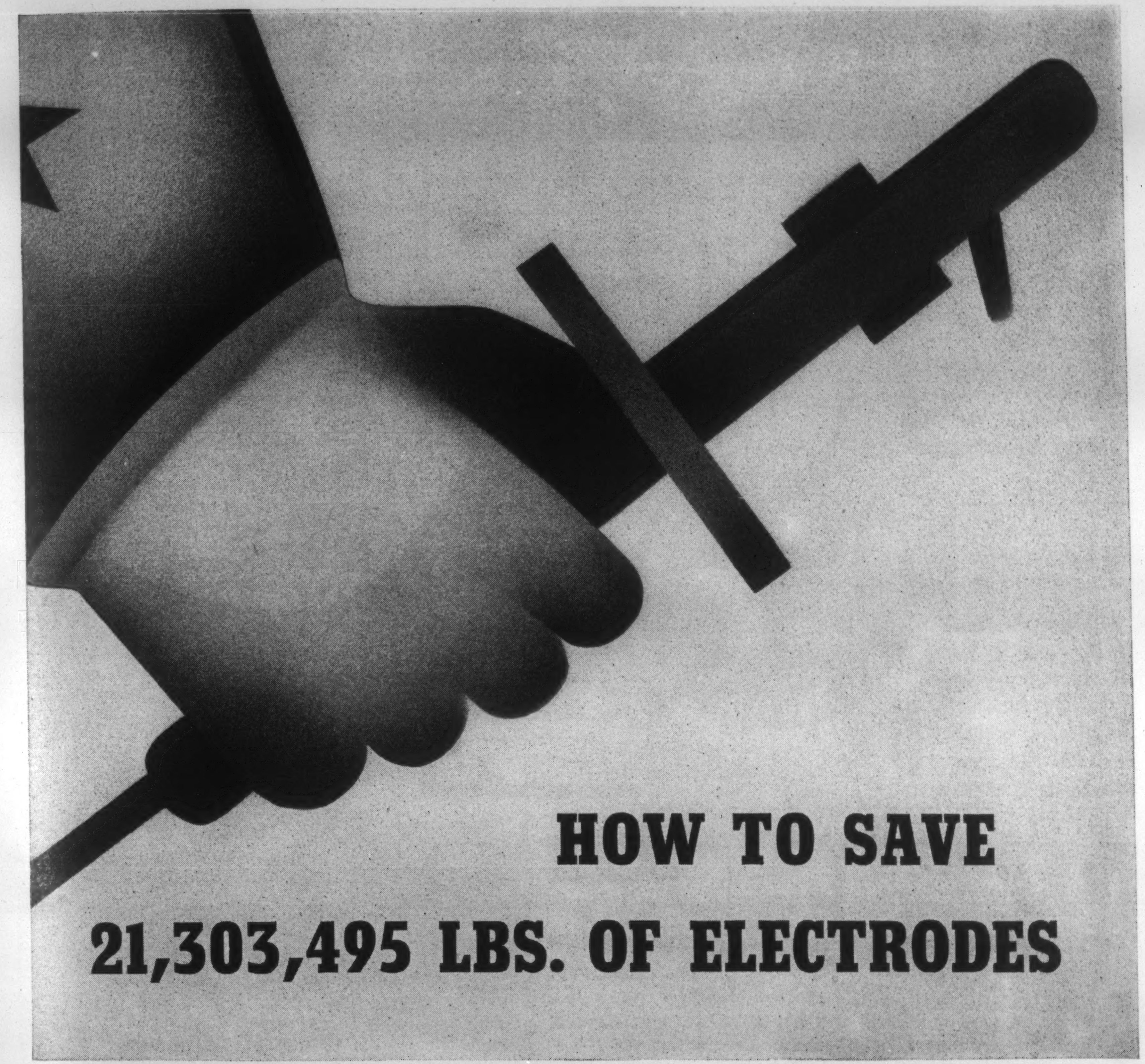

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Ordnance Machine Cutting

Condensed from a Paper before The American Welding Society

With the mechanically operated cutting torch playing an important part in the fabrication of shapes from steel plate, demands for greater accuracy have become increasingly common. The degree of accuracy attainable is dependent upon many factors, but outstanding is that of relative location of plate and torch as affected by motion of the plate while cutting.

Plate motion is created by the expansive and contractive forces which occur, and the direction and extent of this motion with respect to the point of cutting will determine the final shape. A study of this motion discloses that some of the common practices permit an erratic motion pattern and cause shifting of such magnitude as to seriously affect the accuracy.

Where the motion can take place freely and the plate is not restricted, the observation discloses that the magnitude of motion was cut in half and the pattern was uniform. The freedom of motion was gained by mounting the plate on its central section, preventing the scrap and cut from coming in contact with the support.

The analysis of plate motion makes possible a prediction of some of the final errors, and examination on cooling verified this prediction on test plates. Cooling created additional errors, but the final examination disclosed that, with plates mounted to give freedom of motion, the inaccuracies were only 50 per cent of those produced with plates mounted on rough and irregular surfaces.

In regular production the application of control of the most predominant factors has produced extremely accurate results. Other factors also exist which affect the accuracy to some degree although no single factor appears to be as important as that of plate motion.

The design of the shape with respect to simplicity will assist in obtaining accuracy. The design of the machine, its workmanship, and capability of functioning accurately play an important part. Careful maintenance and proper use of the mechanical equipment must be practiced.

The characteristics of the plate such as chemical analysis, surface condition, and heat treatment introduce factors also affecting the accuracy of cut. The chemical analysis will affect the specific setting of conditions for operation while the surface will affect the quality. Internal stresses resulting from heat treatment prior to cutting may develop shifting of the plate while making the cut.

The procedure for cutting is largely a matter of individual examination, and sufficient analysis will develop a basis for predicting the most probable result.

By applying control to the factors which affect accuracy, errors can be kept to a minimum and results can be and are being obtained which are equal in accuracy to that of any other metal working process.

—H. Hughey and A. H. Yorch, *Paper*, Amer. Welding Soc., Oct. 1942 meeting.

At temperatures above 1650° F. encountered in producing high-purity tungsten Inconel serves over 14,000 continuous hours

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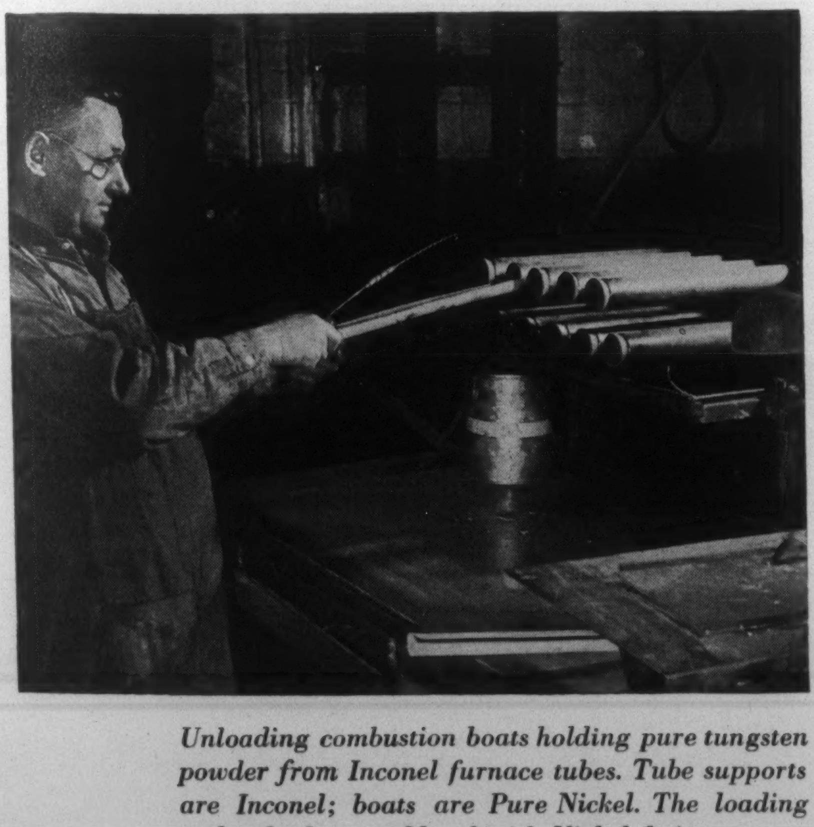
At the plant of Cleveland Tungsten, Inc., seamless Inconel furnace tubes were first put in service five years ago. Since that time these tubes have served over 14,000 continuous hours *without any maintenance.*

Because of the importance and need of tungsten in the war effort, additional furnaces have since been installed. They, too, are equipped with Inconel tubes.

The foregoing details of this successful use of Inconel, a wrought, nickel chromium, heat-resistant alloy, have been published in the belief that they will be of interest and value to engineers and designers working on similar problems, as well as to those who are planning for the future.



Unloading combustion boats holding pure tungsten powder from Inconel furnace tubes. Tube supports are Inconel; boats are Pure Nickel. The loading ends of tubes are Monel with Nickel fittings.

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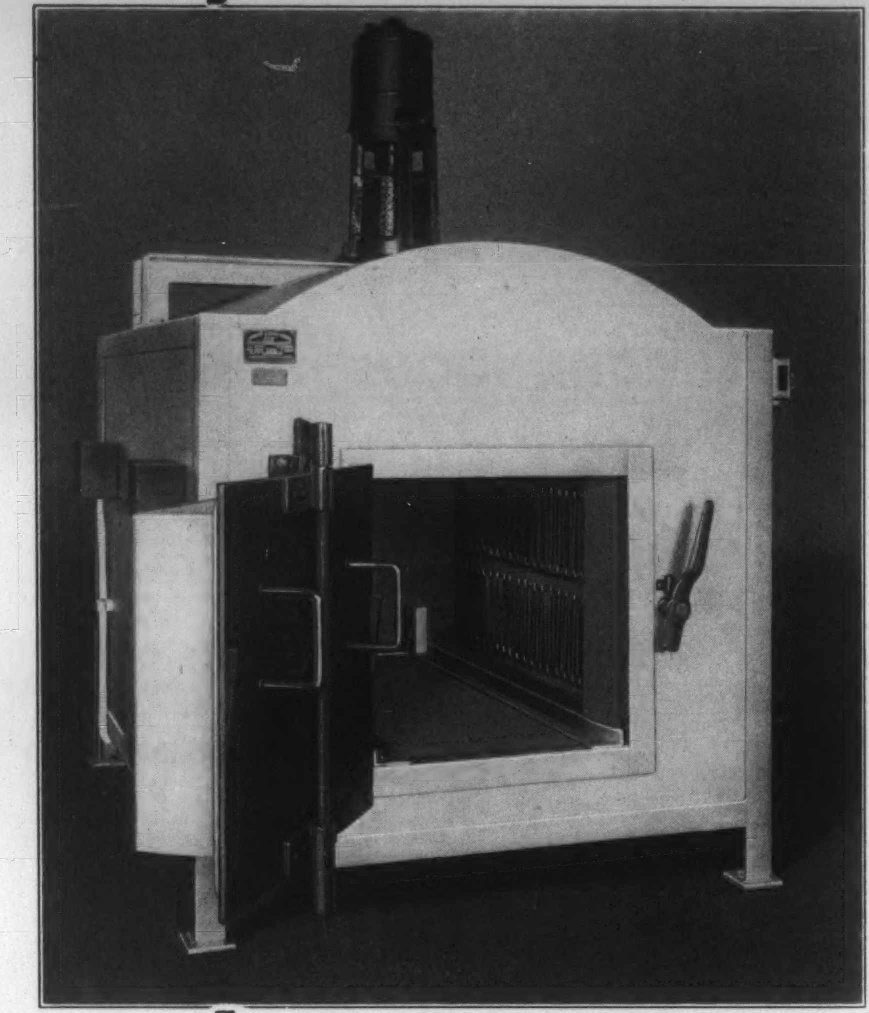

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Industrial Furnaces for All Purposes

Briquetting Machine Shop Scrap

Condensed from "The Iron Age"

It is essential to obtain the full re-use value of the steel and cast iron turnings and borings pouring into scrap dealers yards. Briquetting has been acknowledged as the most economical means of handling this material. In many cases it pays for itself by providing a source of scrap not otherwise available.

A survey has been made of 12 plants, 6 of which briquetted both cast iron and steel, and 6 cast iron only. Die sizes recommended by the machine maker gave the most satisfactory results in most cases. One plant using a small machine, changed from a 2¾ in. to a 3 in. die and is able to handle 4 tons of steel or 8 tons of iron per 8-hr. run.

The melting loss with briquettes was found to average around 5 per cent. Experience is a factor. Plants that for years have studied the action of briquettes in the cupola are usually able to bring the loss to 3 or 4 per cent.

A wide variance in the number of briquettes in each charge was shown. It is largely dependent on the type of casting poured. Fifty per cent is probably the economic maximum under today's prices.

Some typical percentages of briquettes used are as follows: For both high test and soft iron, 30 per cent steel and 30 per cent cast iron. For cylinder iron, as high as 25 per cent cast iron. For alloyed brake drum iron, duplexed in an electric furnace, 50 per cent iron briquettes; 25 per cent pig iron; 10 per cent returns; 1 per cent alloys. For piston and cylinder iron, 10 to 20 per cent steel. For 40,000 tensile iron, 10 per cent cast iron and 8 per cent steel.

Segregation by Analysis

More work on segregation by analysis needs to be done. Some plants separate nickel containing materials from plain iron and steel. One plant separates the material into two silicon classes: 1.90 per cent and over and 1.90 per cent and under. Only minor changes in melting and charging practice are found necessary. All the plants reported that briquetting reduced spout metal cost.

Typical comments on the advantages of using briquettes as compared with ordinary scrap are as follows:

- Lower cost of scrap.
- Analysis of melt can be more closely controlled.
- Charging practice simplified.
- Storage problem simplified.
- Assured scrap supply.
- Uniformity of size.
- Better microstructure.
- More compact metal charges.
- Easier to handle.

Data which would establish costs on a common basis was not obtained. One briquetting machine operator, noted for his work, warned that the lay-out design of a briquetting installation is of the utmost importance in determining final cost. It has an important bearing on labor, one of the largest items of the cost.

—W. A. Phair, *Iron Age*, Vol. 150, Oct. 1942, pp. 31-33.

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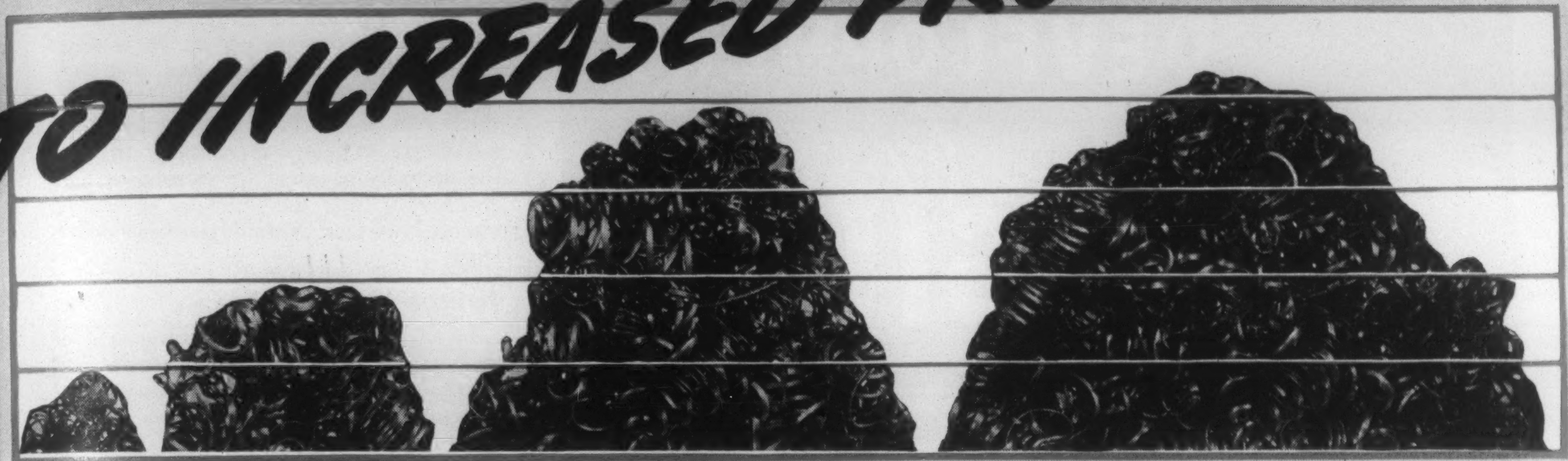

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Tin Plating with Potassium Stannate

Condensed from "Transactions," Electrochemical Society

Because of the present acute shortage of tin, interest in electrolytic tinning to replace hot-dipping has sharply increased. For many purposes electrotinning requires only about one-third as much tin as hot-dipping.

Two types of tin plating bath are now in use: The acid bath and the alkaline sodium stannate bath. The most serious limitation of the sodium stannate bath is the relatively low current densities employable; 25 amp. per sq. ft. is usually recommended and 60 amp. per sq. ft. is about the maximum used.

Although elevated temperatures can be used with the sodium stannate bath, the advantages so gained are partially offset by the necessity of using lower solution concentrations, since the solubility of sodium stannate decreases with increase in temperature.

Potassium Instead of Sodium

In an effort ot retain the advantages of the stannate type of bath while extending its useful range of current densities and concentrations, the authors have investigated the properties of the potassium stannate plus potassium hydroxide system. The solubility of potassium stannate was found to be from 50 to 100 per cent higher than that of sodium stannate under corresponding conditions. Furthermore, the solubility of potassium stannate increases with rise in temperature.

In general the following effects are observed when potassium is substituted for sodium in stannate baths: The conductivity is increased, thus lessening power costs; the cathode efficiency is notably raised; the anode efficiency shows slight but irregular effects; higher operating temperatures are possible; baths are less subject to decomposition with formation of insoluble tin-containing sludge; higher current densities are possible. Quantitative data on the relations between the above variables are presented.

Possible Bath Compositions

Several possible bath compositions are mentioned. For example, a bath containing 290 g. per l. of tin and 30 to 50 g. per l. of free potassium hydroxide can be operated at a cathode current density of 1000 amp. per sq. ft. at almost 80 per cent cathode current efficiency at 90 deg. C. However, the anode current density of these conditions is poor. These conditions would therefore not be generally suitable but could be used for example in high speed continuous plating of wire or strip.

By increasing the potassium hydroxide concentration the anode and cathode current efficiencies can be brought together. Thus, a solution containing 190 to 200 g. per l. of tin and 1000 g. per l. of free potassium hydroxide has anode and cathode efficiencies of 84 and 82 per cent respectively at 150 amp per sq. ft. and 90 deg. C.

Deposits from the potassium baths compare favorably in appearance with those from the sodium stannate bath. Deposits 0.00003 in. thick prepared in the potassium bath were compared by means of the

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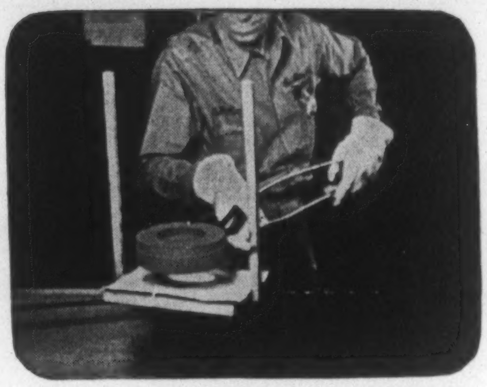
Scale-free hardening by protecting the surface with molten boric acid.



Shrinking a draw ring back to serviceable life after having been worn beyond useful tolerance.

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hot water porosity test with similar deposits from the sodium bath. No significant differences were observed. Semi-bright adherent deposits were produced at current densities in excess of 500 amp. per sq. ft.

When working to electrotinplate thickness, deposits of good appearance were produced at current densities up to about 200 amp. per sq. ft. and there is no reason to suppose that this is an upper limit. Critical anode current densities required for formation of the necessary anode film were determined. The throwing power of the bath is excellent.

—M. M. Sternfels and F. A. Lowenheim, *Trans. Electrochem. Soc.*, Oct. 1942, Preprint 82-24, pages 265-283.

Reducing Tap Breakage

Condensed from "Screw Machine Engineering"

There are certain common causes of tap breakage that may be avoided.

Improper starting conditions may be corrected by adjusting the set-up tools for an adequate chamfer section at the starting edge of the hole being tapped. In tapping a full thread the entire length of the tap drilled hole, it is practical to remove the chamfered section of the tap.

Generally, bottom tapping of unusual threaded parts should not be done on an automatic screw machine. If it is necessary to do so, use a tap of standard commercial design to tap the hole as close as possible to the bottom of the drilled hole. Complete with a second operation tapping machine.

To prevent the tap striking the tap drilled hole bottom, the hole may be deepened or tap penetration depth shortened, if part design permits. If not, the tapped hole should be completed by a second operation.

In order that chips may not crowd ahead of the tap and break it, reduce the chip curler angle on the chamfer cutting lips of the tap to an ordinary hook cutting edge. The chips will then spiral out along the flutes which should be polished and enlarged.

Tap breakage caused by "breaking-out" conditions can be relieved by placing a hook cutting edge on the heel of the tap's cutting lips. Two flute taps, highly polished, should be used.

Commonest Source of Breakage

Perhaps the commonest source of tap breakage is misalignment between the tap and the tap drilled hole. Careful setting of the spot centering and tap drills helps but the tap holders should also be inspected closely and positively aligned. Moderate float in tap holder design aids materially.

Most tapped hole parts produced on automatic screw machines and turret lathes are of this blind or bottom tapped hole type, when machined from bar stock. If the tapped hole is still "blind" after the piece has been severed from the bar, a 90-deg. spot centering drill is followed by a standard 118-deg. tap drill and tapped as desired.

After cutting off a blind hole part the end of the bar is flat. To counteract

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deflection of the centering drill, on striking a flat surface, its web section should be thinned to reduce the point's flat contact. This promotes concentricity between machine spindle centerline and a 90-deg. spot centering drill. If a threaded hole part is cut off from the bar with a tapped through hole, the spot centering drill will not contact the flat surface. It meets the drilled spot left by this tap drill.

A spot centering drill is often used as a truing tool, by arranging to leave a spot at the end of the succeeding part. The concentricity of the spot should be under positive control and at no time exceed the eccentricity limits of the part drawing.

A spot nearly central in cut-off position will seldom run true in feed-out location. Although the collet is manufactured to strict concentricity requirements in the gripping hole size and angular closing surfaces, it will not grip a bar stock center. Dirt and chips accumulating also put the spot off center. In contacting the eccentric spot, the spot centering drill or the bar stock "spring" to one side. This must be eliminated or reduced to a minimum.

Rigidity, important in the designs of tools used as "bottoming" drills or spot centers, may be secured by using a short grip drill, close to the centering end.

In many cases a tapped hole part, when cut off, appears as a through hole part and a spot is left by the tap drill. If preferred the cut-off tool blade width can be increased until it removes all of the chamfered section of the tap from the through tapped hole.

Correcting an Eccentric Spot

An eccentric spot may be corrected by using a 90-deg. spot centering drill. Drills with an included angle of 118 deg. and smaller in size than the outside diameter of the spot, start cutting action at the peripheral edge of the spot drilled hole instead of contacting the flat surface.

Angularity extremes cause a strain, invite chatter and destroy the peripheral points of the cutting lips. A drill with an included angle of 90 deg. promotes the self centering action of the following drill and provides an effective chamfer at the edge of the hole. This is advantageous as a starting angle for efficient tapping.

Using a cut-off tool with the greater than normal blade width is a wasteful method. To prevent wastefulness, tap clearance is secured by extending the tap drilled hole beyond the position of the cut-off tool. After severing from the bar, the stock is fed forward with the partially drilled hole already in place. It must be in perfect alignment, or the tap drill can not cut a concentric hole for the tapping operation to follow.

—*Screw Machine Engineering*, Vol. 3, Oct. 1942, pp. 29-31, 34, 35.

Hot Heading of Bolts

Condensed from "American Machinist"

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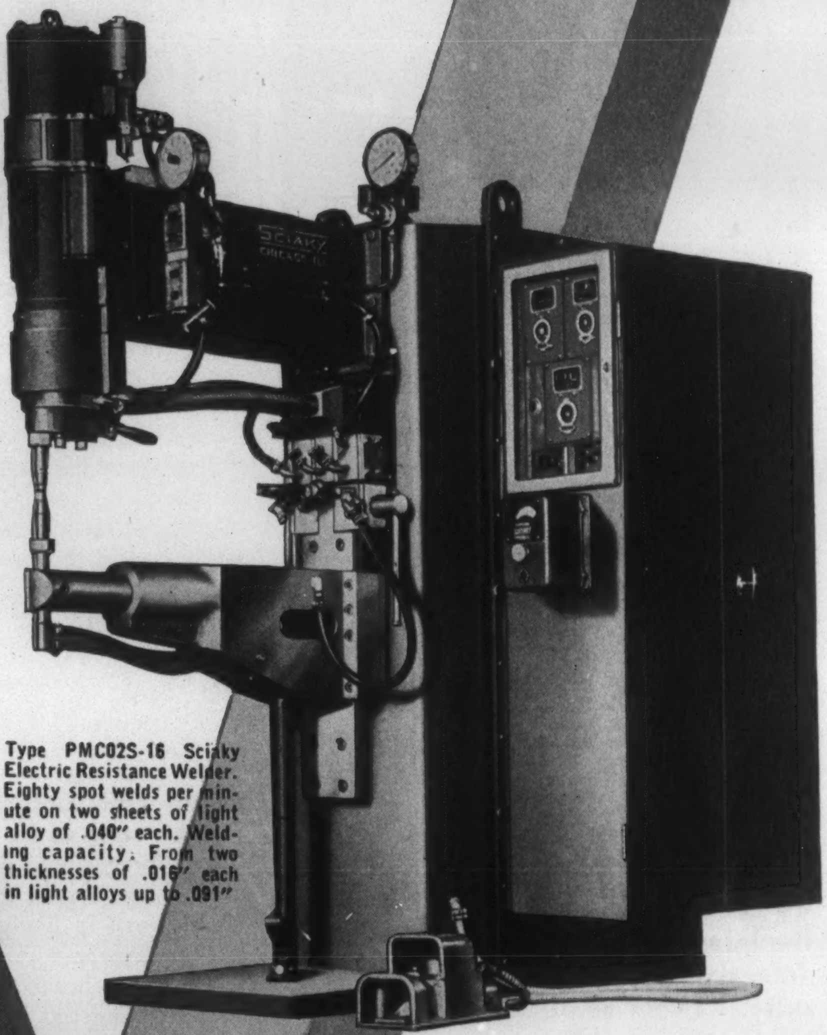

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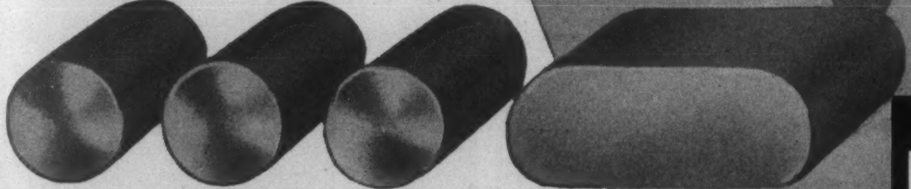

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excellent and close dimensions can be held.

Much hot heading is done on stock from 1 to 2.5 in. in diameter, although some is done on small diameters down to ⅜ in. or under. Such work is chiefly when the quantity is not sufficient to warrant a cold heading die or when the length exceeds that which is feasible to handle in a cold heading machine. For hot heading, the stock is generally cut to length before it enters the heading machine.

The operation is less rapid than cold heading, but die cost is lower. Any material which can be hot forged can be hot headed, so the range of materials is wider than for cold heading. Hollow and some other shapes of heads rarely produced by cold heading can be hot headed. Offset heads not symmetrical about any axis can be formed. A large proportion of hot headed parts are produced in standard forging machines also called tong headers.

Another machine used for products such as rivets and bolts operates much like a cold header in that it shears the stock to length and heads it automatically. When the product is to be heat treated, it slides down a chute into a quenching solution.

Each machine has its own furnace which is designed especially for the job with a narrow throat a few inches above the water cooled hearth over the edge of which the ends of the blanks to be heated project. Only the length to be upset extends into the furnace, thus conserving fuel and keeping the dies at lower temperatures.

Flash may be removed by shearing or by forcing the bolt head through a trim die in a punch press. Except for flash removal, operations such as threading, etc. are the same as for cold headed products, but if dimensional limits are to be as close as can be held in cold heading, more machine work is likely to be needed on the hot headed part.

Many hot headed as well as cold headed products undergo heat treatment.

—H. Chase, *Am. Machinist*, Vol. 86, Sept. 3, 1942, pages 952-955.

Friction with Various Cutting Fluids

Condensed from "Transactions," A.S.M.E.

A series of tests were made to determine the lubricating effects of a wide variety of cutting fluids on the forces involved in drilling; measuring methods and apparatus used are described in full. The results of the friction tests show that under conditions of seizure, mineral oils and water produce approximately the same high coefficient of friction at relatively low pressures, and that considerable metal is displaced.

When sulphurized oils are used under conditions of seizure, the friction coefficient is greatly reduced, and there is very little metal displacement or seizure even at high pressures. Emulsions containing active sulphur also reduce the coefficient of friction between the friction surfaces in the same manner as that produced by the sulphurized oils. Only at very high pressures was the sulphurized-oil film ruptured to permit metal-to-metal contact and seizure.

SOME SPECIAL JOBS for which ADAMANT
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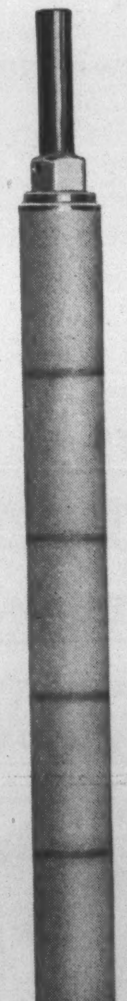

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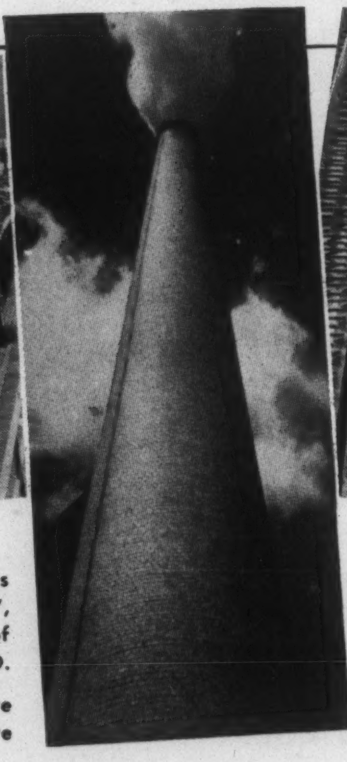
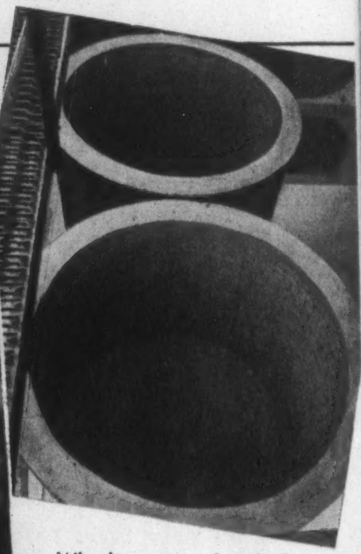


Stacks with Atlas Acid-proof linings are proof against the attack of corrosive fumes.



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Carbo-VITROBOND—inert to hydrofluoric and nitric acids, used in pickling stainless steel.

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Cutting fluids, even those which possess high sulphur content, high antiseizure properties, and low coefficient of friction in the friction tests, will not decrease the cutting forces unless there is rubbing friction on noncutting surfaces where the antiseizure properties become effective. The relative values and distribution of torque and thrust for a drill of 11/32 in. diam. were determined for the drill as a whole and for cutting and chisel edges.

—A. O. Schmidt, W. W. Gilbert & O. W. Boston, *Trans. Am. Soc. Mech. Eng.*, Vol. 64, Oct. 1942, pp. 703-709.

Welding With Aluminum Bronze

Condensed from a Paper before the American Welding Society

Aluminum bronze in a welding rod is relatively new to welding. The refractory oxide that so quickly forms on aluminum bronze when it is melted by either an oxy-acetylene flame or electric arc has in the past prevented its widespread use as a welding rod and also limited wide applications of welding on aluminum bronze castings, rolled sheets or extruded shapes.

The desirable properties of aluminum bronze, especially its high strength and "hot-ductility," particularly suit a weld-rod alloy and have encouraged the development of a fluxed weld-rod which would allow the use of this alloy for arc and oxy-acetylene welding.

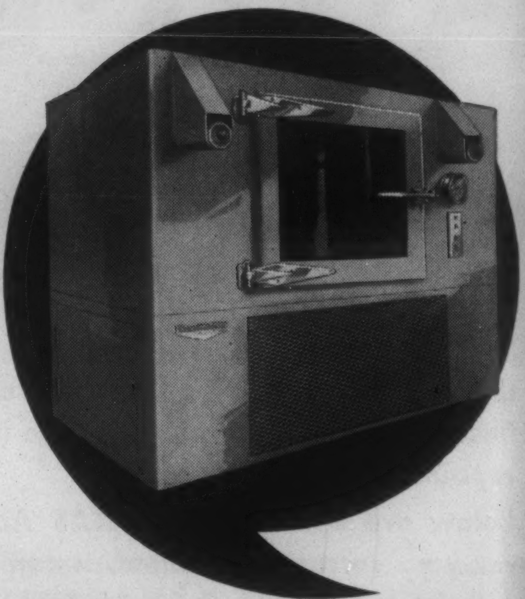
The alloys of aluminum bronze in which coated electrodes are available range from 8 to 14.4 per cent Al, 0.5 to 5 per cent Fe, and the balance copper. These alloys vary in tensile strength from 60 to 90,000 lbs. per sq. in. with a hardness range of from 109 to 352 Brinell. The elongation of these bronzes varies from 0 to 30 per cent in 2 in., measured on a 0.505 in. diam. tensile specimen.

Rod for General Welding

An aluminum bronze weld-rod alloy suitable for general bronze welding applications has a composition of 88.5 to 90.5 per cent Al, 0.5 to 1.0 per cent Fe, and the balance copper. The weld metal from this alloy will develop 60 to 70,000 lbs. per sq. in. tensile strength, have a yield strength of 25 to 32,000 lbs. per sq. in. and an elongation of 25 to 30 per cent in 2 in. The Brinell hardness would be 110 to 130 as measured with a 3,000 kg. load and 10 mm. ball.

Coated electrodes of this type have been successfully used for arc welding copper-zinc alloys, such as manganese bronze, Muntz metal or common brass. The weld metal from these electrodes developes the full strength of the standard manganese bronze, which is used for making ship propellers and other castings where high strength and good corrosion resistance are required, and gives equal corrosion resistance.

To obtain the best results the casting need only be preheated to about 500 deg. F., instead of at least twice that temperature, as required for gas welding. This electrode may also be used for joining dissimilar metals; such as, brass or bronze to steel or cast iron. It should be noted, however, that its use on cast iron is limited to that iron which is free from grease and rust.



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Hoffman Filters effectively remove abrasives, chips and dust from coolants recirculated on machine tools, and give an abundant flow of clean coolant over long working cycles. They effect important economies in the life of tools and abrasive wheels, eliminate scratches on precision-finish, hardened-and-ground articles, and reduce rejects and failures in service. They are especially valuable to manufacturers of gun and aircraft engine parts, gages, ball bearings, etc.

Hoffman Filters are built either in smaller sizes for application to individual specific machine tools or in larger sizes for centralized coolant treatment. The above illustration shows Hoffman equipment for supplying continuous flow of clean coolant to sixty automatic thread grinding machines.

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An aluminum bronze containing 12.8 to 13.5 per cent Al, 3.9 to 4.7 per cent Fe, and the balance copper, makes an excellent electrode alloy where a very hard bronze is required. The weld metal from such an electrode develops 70 to 80,000 lbs. tensile strength with a minimum yield strength of 42,000 lbs. per sq. in. and a Brinell hardness of 285-311.

It is widely used as a welded overlay where a hard bronze with good bearing qualities is required to stand up under heavy bearing pressures or where pounding might deform a softer bronze. And it is also used for building up worn forming and drawing dies for work on carbon and stainless steel sheets where freedom from scratching and galling is required.

Coated Weld Rods

The average welder has no difficulty in successfully applying coated aluminum bronze weld-rods as long as he keeps in mind the fact that a "braze" is required, rather than a weld with deep penetration. In general, it is not desirable to obtain a wide fusion line in which the base metal and the aluminum bronze are melted together. A wide fusion line on copper-zinc alloys may result in lowered ductility. A wide fusion line on steel or cast iron may mean hard spots in the overlay, which will interfere with machining and performance.

The aluminum bronzes with their high strength and wide range of hardness present to the welding industry a group of bronze electrodes suitable for many new applications. Their "hot-ductility" makes their use possible with little fear of hot-short cracks.

—C. E. Swift, Paper, Amer. Welding Soc., Oct. 1942 meeting.

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The processing of magnesium need no longer be hazardous. The development of Hydro-Whirl, which employs a new principle in wet dust collecting, definitely encourages further use of this alloy and widens its potentialities.

Dust emanating from grinding and polishing operations in the work compartment is drawn down through the bench-high grating where it is trapped as it passes through water. This then forms a sludge which can be easily removed at intervals.

The cleaned air in the meantime is diverted to another direction and is returned to the room without appreciable loss of heat.

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"Drag-in" During Plating

Condensed from "Monthly Review," American Electroplaters' Society

Although drag-out as a factor in the operation of plating baths has been considered for at least 15 yrs., it is only recently that attention has been given to drag-in. Raw tap water contains many impurities. Dissolved compounds of calcium, copper, magnesium, iron, carbonate, chlorine, and organic materials, suspended solids, and dissolved gases such as hydrogen sulphide and chlorine are only a part of the impurities which may be present.

As an example, calcium bicarbonate, a common impurity in tap water, can cause trouble with acid copper, with bright nickel, or with cyanide baths. It is erroneous to think that the concentrations of these impurities in water are too low to affect a plating bath. Only 0.75 parts per million of carbon disulfide has a marked effect on a silver bath, and most raw waters have solids contents of 50 parts per million and more. Furthermore, by a combination of the effects of drag-in of impurities in the rinse water and evaporation of water from the bath, the concentration of the impurity in the bath can be greatly increased.

The Mathematics of Drag-In

A mathematical analysis of drag-in leads to the following equations:

$$(1)\quad C_x = C_1 + \frac{n_1}{V_0}\left[(a + b)\,C_0 - a\,C_1\right]x$$

$$(2)\quad C_x = \frac{n_1}{V_0}\,(a + b)\,C_0 x$$

$$(3)\quad C_x = C_0\left(1 + \frac{n_1 b x}{V_0}\right)$$

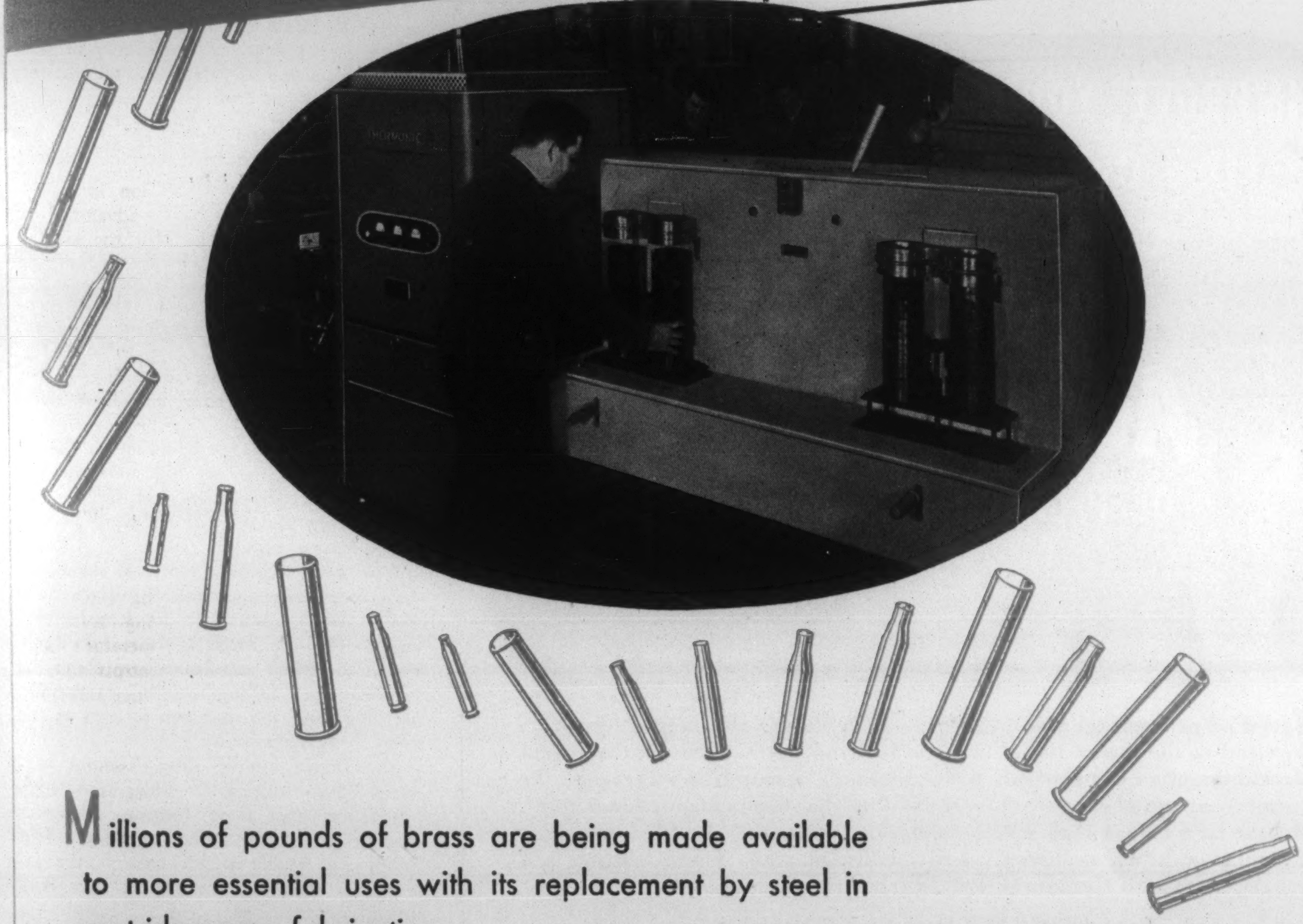
$$(4)\quad C_{oo} = \left(\frac{a + b}{a}\right)C_0$$

In these equations, C_x is the concentration of a given impurity in the solution after x days of operation; C_1 is the initial concentration of the substance in the plating bath; n_1 is the average number of pieces or racks plated daily; V_0 is the volume of the plating solution; a is the volume of drag-in or drag-out per rack plated, b is the volume of plating solution evaporated per rack plated; C_0 is the concentration of the substance in the water used for rinsing; C is the limiting value of the concentration of the substance after a large number of days of operation.

Equation (1) is a general equation covering any case. Equation (2) is for the special case where distilled water is used for making the bath, as is done with precious metal baths. Equation (3) is for the ease where tap water is used for making the bath, so that $C_1 = C_0$. These three are simplified forms of more accurate equations, but are sufficiently accurate for practical purposes.

Thermonic

The Answer to the Annealing Problem in the manufacture of Steel Cartridge Cases



Millions of pounds of brass are being made available to more essential uses with its replacement by steel in cartridge case fabrication.

In transforming the production line to steel, annealing and stress relieving have been the difficulties encountered.

The rapidity and control of Thermonic High Frequency Induction Heating has provided the solution to the problem in sizes from 20mm. to 105mm.

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Some Specific Examples

Equation (4) is exact. Equation (4) shows clearly how important drag-in may be in some cases. For example, for a cleaning tank operated at 200 deg. F. the rate of evaporation per piece plated may be as much as 1000 times the drag-out per piece plated, *i.e.,* b may be 1000 times a.

In this case the limiting value of the concentrations of the impurities in the cleaner will be 1000 times their concentrations in the tap water. This may explain why cleaning baths in some localities go bad much sooner under the same load than in others.

In another example cited, a 1000 gal. bright nickel bath gives a dark deposit when the copper concentration reaches 0.002 oz. per gal. Because of a copper sulphate treatment of the local water, the copper concentration in the water is 0.0001 oz. per gal. Evaporation is 400 gal. per day for 2000 racks plated. In how many days will the solution go bad because of the build-up of copper? Equation (3) when solved for x gives:

$$(5)\quad X = \frac{(C_x - C_o)\,V_o}{n_1 b C_o}$$

Substituting the above values in Equation (5) gives:

$$X = \frac{(0.002 - 0.0001)\,(1000)}{(2000)\,(0.2)\,(0.0001)} = 47.5 \text{ days.}$$

These examples indicate how drag-in can affect plating solutions and how the effects can be computed.

—Joseph B. Kushner, *Monthly Review,* Am. Electroplaters' Soc., Vol. 29, Sept. 1942, page 751.

Air Hammers for Forging

Condensed from "Heat Treating and Forging"

The wisdom of substituting compressed air for steam in forge hammers has been questioned in regard to cost. The answer lies in the fact that a hammer-cylinder uses steam uneconomically.

The theoretical steam cycle efficiency is no better than 11 to 12 per cent, while a central station of average performance has a theoretical steam-cycle efficiency of some 33 per cent and an actual thermal efficiency of 16 to 18 per cent.

Handicaps of Steam Hammers

Steam hammers have certain unavoidable handicaps as follows:

1—The difficulty of properly insulating the cylinder and intake pipes causes severe heat losses, resulting in heavy steam condensation.

2—The consequent rapid cylinder- and piston-ring wear, resulting in heavy steam condensation.

3—High stand-by losses result from a usually poor load-factor and high transmission losses.

The absence of condensation in the air hammer constitutes its big advantage, as it results in the efficiency of the air cylinder being about twice as good as that of the steam cylinder.

The two principal types of hammers, (not considering mechanically driven hammers) are the impression-die drop hammer and the flat-die forge hammer. In both, the air or steam acts below and above the piston. The "falling weight," in pounds, of the piston, rod and ram is used as the nominal hammer rating.

The impression-die drop hammer produces "drop forgings." Long runs, high production and close forging tolerances characterize it. As the operator's foot leaves the treadle which controls the intensity of the blow the hammer ram goes into idle oscillations.

The flat-die hammer does work more nearly resembling hand forging. Many hard blows in quick succession are followed by longer periods of idleness. Between heats the ram is at rest.

Drop Hammer Oscillation

The necessity of the oscillations in the drop hammer is predicated, entirely, on the use of steam. Tests show that, for about three-quarters of the working day, air is used up in idling and that the air so consumed is $1\frac{1}{2}$ times as much as the amount used in actual productive work.

This waste can be eliminated by making the hammer non-oscillating, provided the mechanical devices (treadle, toggles, cam, valves and cylinder) are so designed that flexibility or striking power of the hammer blow is not sacrificed. As the operator's foot leaves the treadle, the ram must be lifted at once to mid-stroke or higher.

This uses only a fraction of the air required for oscillation. A new cylinder,

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Speed of penetration and uniformity of depth are advantages long recognized in the use of liquid bath carburizing. Now, through the recent development of a new bath by Cyanamid's research laboratories, the formerly accepted case depth limit of 0.036″ has been extended to 0.125″. A base bath (No. 13) to which an activator (No. 40) is added, provides chemical stability, uniformity and quality of case. These features are synonymous with Cyanamid liquid carburizing compounds.

A bath of the AEROCARB Deep-Case Carburizing Compounds possesses the following characteristics:

Temperature of operation—1700° F—1750° F.
Density of molten bath at 1700° F—136 Lbs./Cubic Feet.
Cyanide Decomposition—Approximately 1/8 of 1% per hour.
Penetration—Unsurpassed by other methods.
Hardness—Rockwell C-67 has been developed on SAE 1020 Steel.
Case Composition—Outer layer is hypereutectoid—over 75% of total case is over 0.040% carbon.

Cyanamid case hardening and carburizing compounds provide baths covering a case depth range from 0.001″ to 0.150″. Investigate Cyanamid products for any problem involving case hardening and carburizing. The experience of a staff of technicians and the facilities of our laboratories are at your disposal.

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Strip steel . . . needed for aircraft assemblies, destroyer smokestacks, "jeep" bodies, Army field kitchens and bomb fins . . . for literally thousands of military and industrial purposes . . . is speeded to war production plants by welding with Mallory Flash Welding Dies.

In one of the world's largest strip mills, the resistance flash welder shown above joins single coils of strip steel to form multiple coils. Major advantages are:

1. *Speedier Production.* It is much faster to "thread" multiple coils through picklers, rolling mill stands and shears than to thread shorter, single lengths of strip.
2. *Greater Uniformity.* The percentage of "off-gauge" and scrap steel is minimized.
3. *Meeting Customers' Requirements.* Many users prefer longer, heavier coils.

Flash welding is the best commercial process for joining strip in steel mills, because the welds are made automatically. Operators are quickly trained. Machine maintenance can be kept to a minimum . . . especially since most flash welders are equipped with dies produced by Mallory, and these dies assure more welds between dressings, a higher total number of welds before replacement is necessary, and thus sounder, more uniform welding.

Mallory Standardized Welding Electrodes—spot welding tips, seam welding wheels and flash welding dies—are used in major steel and copper mills, in aluminum and magnesium plants . . . in factories turning out war planes and parts for aircraft, ships, shells, guns and tanks. Mallory's long research has led to superior electrode materials, designs and cooling methods . . . Today Mallory is developing new electrode designs, new non-ferrous alloys and powdered metal products to help weld the way to Victory!

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A BOOK YOU WANT for your technical library is the latest *Mallory Resistance Welding Data Book.* Facts on spot, seam and flash welding ferrous and non-ferrous metals and alloys. Write for your copy today!

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RESISTANCE WELDING **P.R. MALLORY & CO. Inc. MALLORY** **STANDARDIZED ELECTRODES**

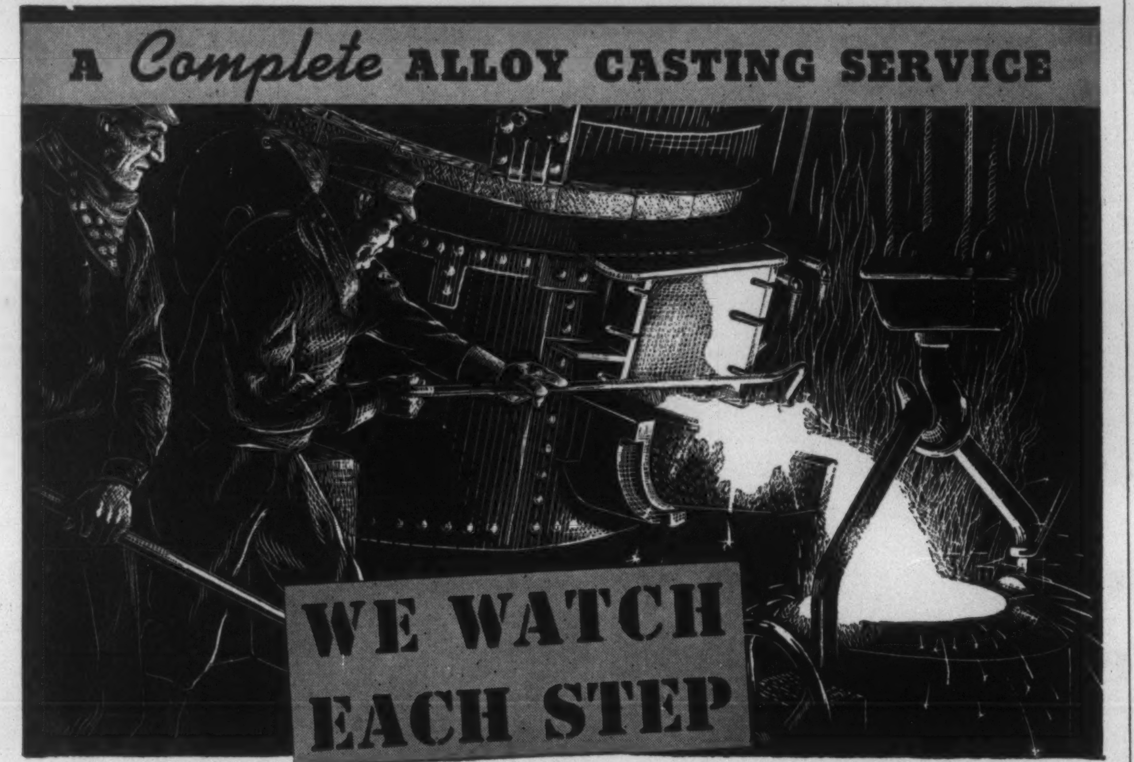
valve and valve motion can be adapted to any existing hammer. Two such hammers, at work for 3 yrs., have proved a saving in air of 40 to 50 per cent.

Compared with a steam-operated, conventional impression-die drop hammer, an air-operated, non-oscillating drop hammer proves cheaper to operate. Actual results depend on the cost of steam and compressed air in any particular plant. An average price of 60c for 1000 lbs. of steam and 12c per 100 cu. ft. of air makes the respective "power" costs of a 1500-lb. impression-die drop hammer, about $15 per 8-hr. day for steam and about $9 for air.

A compressor installation is cheaper than a boiler plant. Rebuilding an existing forge shop for air operation would cost more than new boilers but, in an average case, the savings would pay the difference in less than three years, if operating 40 hrs. a week, and in a little over one, if running 120 hrs. a week.

Hammers, converted from steam to air, without being changed to non-oscillating operation, will show no appreciable saving in operation. They do give greater comfort to the operators, lower maintenance cost of cylinders, valves and piping, and a snappier blow at equal pressure.

—Joseph M. Weil and Paul Hoffman. *Heat Treating and Forging,* Vol. 28, Oct. 1942, pp. 519-521.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- Machine shop . . . specially equipped for finishing stainless steel.
- Improved cleaning . . . including Lustracast electrolytic finishing which leaves all surfaces bright.
- Castings furnished rough, polished or fully machined . . . one ounce to two tons.
- Development of special alloys to meet unusual requirements.
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Polishing Methods Prior to Plating

This is a report on the results so far obtained in an investigation to determine what effects are produced upon the protective value of plated coatings by variations in the methods of polishing the base metals prior to plating.

The final conclusions will be based chiefly upon atmospheric exposure tests that are now in progress. The exposure tests have run long enough to allow tentative conclusions which are however subject to revision in the light of more complete data.

The surface finish of the steel used was bright and smooth and yielded profilometer readings from 2 to 4 RMS micro-inches. Finishes used for the test panels ranged from "Superfinished" surfaces, through the above described cold-rolled finish to a 90-grain polish finish.

Other grain sizes used for polishing specimens are 150, 220, 320, and combinations of these, applied both dry and with oil. Two sets of 220 grain, grease polished panels, and two with an aluminum oxide "greaseless" finish were also included.

Panels were plated with varying thicknesses of dull nickel alone, which was buffed in some cases, with bright nickel alone, and with copper followed by either bright or dull nickel. Details of bath compositions, and cleaning and buffing procedures are described.

The exposure tests show that up to the present length of exposure, no significant affects of polishing have been observed. Of those few sets in which unbuffed dull nickel was compared with buffed nickel, the unbuffed specimens showed a marked superiority only on the unpolished cold-rolled steel. On sets polished with 150 or 220 grain, the buffing of the nickel had no such large effect.

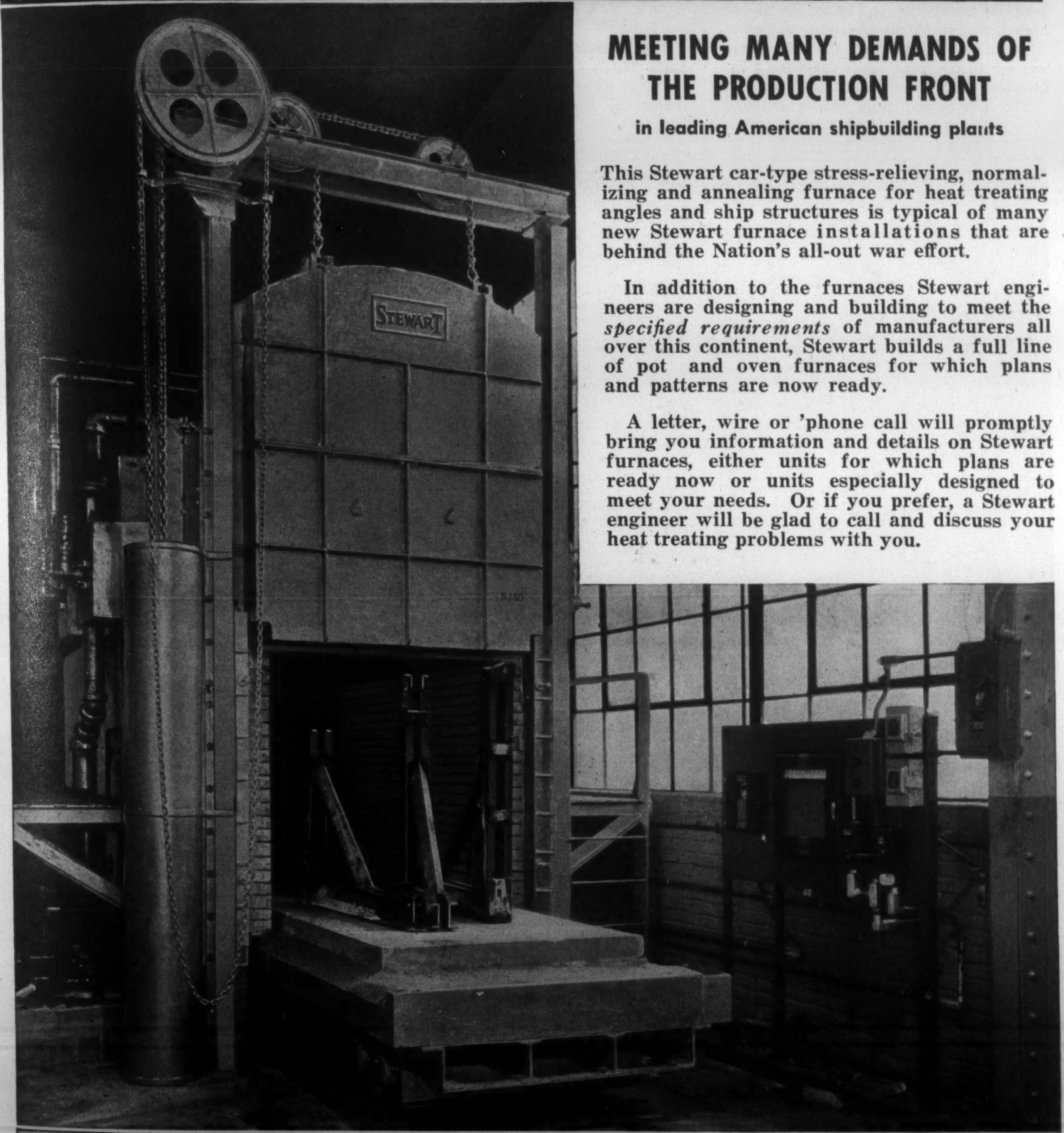
The sets with buffed copper under bright nickel were distinctly better than those with bright nickel of the same total thickness applied directly to the steel. This result is not consistent with the previously reported detrimental effect of copper under buffed dull nickel. Further tests on this point are in progress.

Accelerated Tests

Four kinds of accelerated tests were carried out to determine the correlation of these tests with the exposure data and to provide a basis for setting up acceptance specifications. The salt spray test was conducted with a 20 per cent solution of sodium chloride at 95 deg. F. The specimens were hung vertically and their positions changed every 24 hrs.

The results were erratic and showed no correlation with exposure test results. The behavior suggested that the salt spray was slowly attacking the coatings, producing pores where none existed before. To check this, weighed pieces of detached nickel foil, both dull and bright, were exposed in the salt spray for 8 days. The loss in weight was negligible, but numerous fine holes were produced in the foils, which by visual examination had been free from pores before the test.

These results cast doubt upon the value of the salt spray test for detecting pores in



No. 36 OF A SERIES of Typical Installations

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FROM A 25 TON CAR-TYPE ... TO A 6 INCH POT

nickel coatings. The Strausser modification of the ferroxyl test showed no correlation with the exposure tests. In the hot water test the specimen is immersed for 6 hrs. in distilled water kept at 194 to 203 deg. F., removed, and allowed to dry in air. Any visible rust spots are recorded. Again there was no correlation with the outdoor exposure tests.

In the moisture-condensation test, which has been recently used in testing paint coatings, the specimens are cooled in air of high humidity so that moisture condenses on them for 5 hrs., then allowed to stay wet for 18 hrs., and finally dried for 1 hr. in warm dry air.

This test proved to be slower and less discriminating than the other accelerated tests. These results show that these porosity tests hardly warrant inclusion in acceptance specifications and that much more research is needed to standardize these tests or to devise others more reproducible and significant.

—Gerald A. Lux and Murray Berdick, *Proc.*, Am. Electroplaters' Soc., 1942, pages 19-26.

Prefabricating Aluminum Parts

Condensed from "Aviation"

The Aircraft Parts Division of the Reynolds Metals Co. is now equipped to fabricate, at the sheet source of supply, practically any flat part specified by aircraft manufacturers. Negotiations are under way for the installation of Anderson "Forming-by Drawing" machines, to produce a variety of formed parts.

There are two main fabrication plants; one for all blanking and shearing operations, complete from die-making to inspection departments; another for the production of all routed parts, also complete from template-making to shipping.

Present production, being largely of flat parts, permits highly efficient straight-line production. The die shop is equipped to complete tooling for a large variety of orders. All dies are classified and filed, resulting in a saving of cost, time and effort and the immediate production of repeat orders.

The Two Main Shops

The blanking shop has a constantly increasing capacity of over 250,000 lbs. of finished parts per month. The shearing department can handle nearly 2,000,000 lbs. of sheared panels and parts per month. The diversity of orders and large selection of parts of different shapes being worked on simultaneously, makes it possible to use the salvage immediately.

The routing plant has the capacity to turn out an average of 400,000 lbs. of finished parts per month. All routing equipment is adaptable to cutting a number of parts at a time and the largest unit is double-armed. Finished routed parts are drilled to specifications, again with double-armed machines.

Drilled parts are deburred and cleaned before inspection which is under Government supervision. Packing is done with meticulous care to utilize the minimum amount of freight space and deliver in good condition.

The two plants can handle and process over 3,500,000 lbs. of sheet monthly.

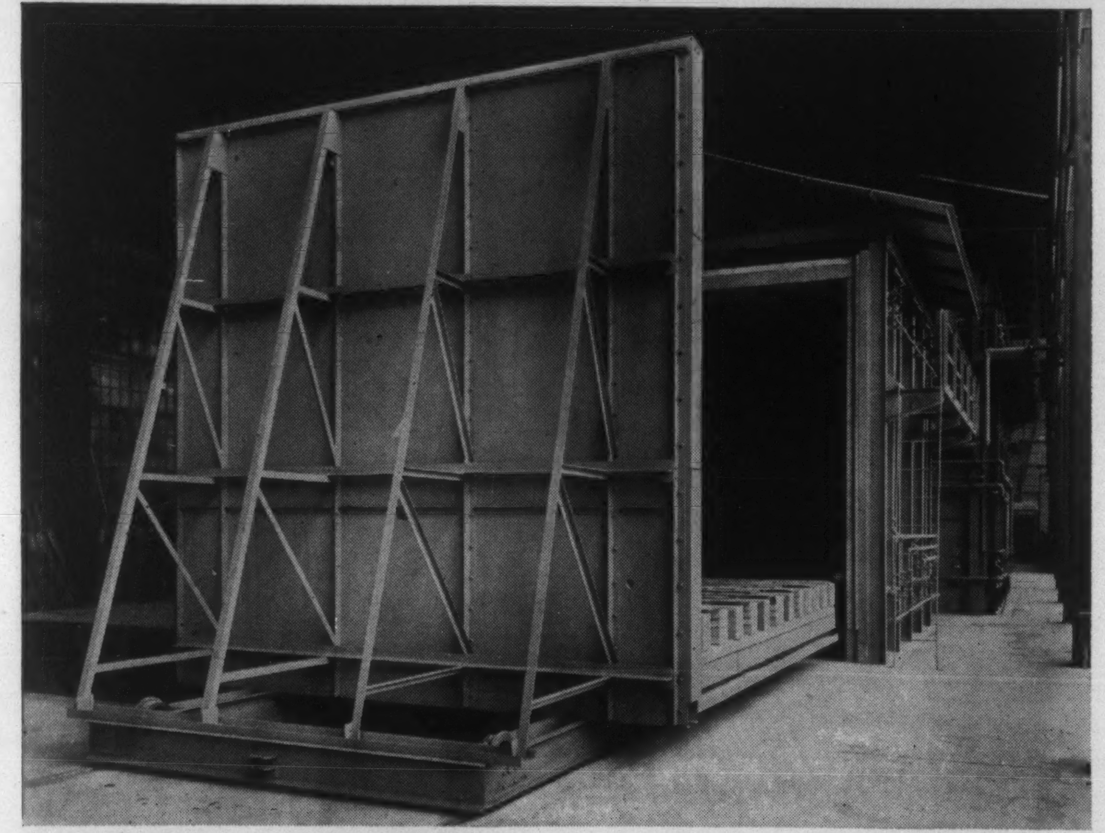
The Reynolds plan has all the recognized advantages of subcontracting: Efficient utilization and concentration of a skilled labor pool; elimination of duplicate machinery and tools; reduction of slow, semi-automatic operations of small lot parts; and release of floor space, manpower and managerial effort in production plants.

Large Return of Sheet Scrap

Equal to these advantages is the retaining of scrap aluminum at the sheet source. An approximate average of 30 per cent of sheet aluminum sent to aircraft plants is returned as scrap. It is equivalent to 9,000,000 lbs. per month, may be tied up from 3 to 6 months in transit, and utilizes vital freight capacity. In addition, the handling and storing of scrap in airplane factories increases production costs and a considerable amount is rendered useless by contamination.

As more plants are erected to build similar types of planes, the multiple duplication of fabricating facilities approaches overall inefficiency. The tool making capacity of the country is already strained and the small quantity of certain parts produced by one company makes quantity production tooling too costly.

—W. G. Reynolds and David P. Reynolds, *Aviation*, Vol. 42, Oct. 1942, pp. 108-113.



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A new method of direct firing, in the Vulcan Car Hearth Furnace illustrated above, produces a convection effect and provides greater efficiency and economy in the heat treatment of castings and weldments. Advantages: Less time to uniformly heat the charge to temperature; better uniformity at temperature; more rapid, uniform rates of heating, even when charge is not uniformly loaded in furnace; elimination of localized high temperature areas, thus reducing furnace maintenance and lengthening furnace life. Oil or gas fired, with several zones of control.

Send for complete information about this and other Vulcan custom-built furnaces for Annealing, Normalizing, Stress Relieving and other Heat Treating Operations; Forging, Melting and Special Heating work.

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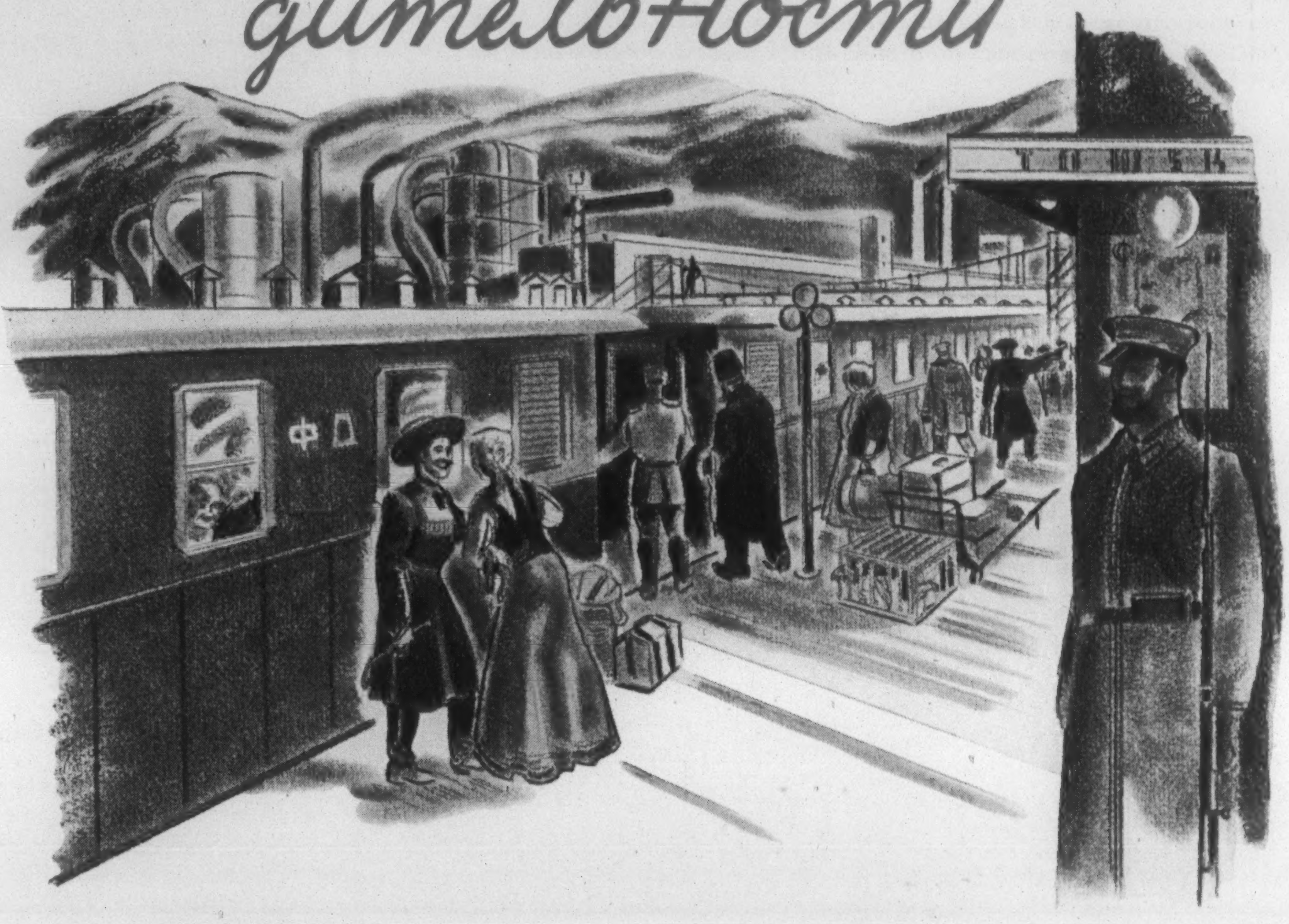

This caption may puzzle you. It is the most quoted German proverb, best remembered by the Russians. Above, it is lettered in Russian script, reading "FORESIGHT IS THE MOTHER OF WISDOM."

Russian industrial development in and beyond the Urals was planned as a protection against the inevitable conflict which began in June, 1941. The industrial cities of Uralsk, Magnitogorsk, Omsk, Sverdlovsk, Ufa, Kuibyshev and a dozen others, furnished equipment from an area beyond reach of the strongest military power in Europe. Hence it was Russia's WISDOM OF FORESIGHT that prevented defeat in the Fall of 1941.

If American industry possesses a comparable WISDOM OF FORESIGHT in planning POSTWAR operations, then private enterprise, with its renewed public confidence, will move forward with amazing advancement for the general welfare, in the traditional American way.

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4

Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Embrittlement of Boiler Steel

Condensed from "Transactions," American Society of Mechanical Engineers

Five papers were read and discussed in a recent A.S.M.E. symposium on embrittlement: (1) "Results of Laboratory Embrittlement Testing of Boiler Waters" by F. G. Straub; (2) "Embrittlement of Boiler Steel — Experiences with the Schroeder Detector" by T. E. Purcell & S. F. Whirl; (3) "Experience with Intercrystalline Cracking on Railroads" by R. C. Bardwell & H. M. Laudemann; (4) "Studies on the Cracking of Boiler Plate" by P. G. Bird & E. G. Johnson; (5) "Field Data from the Embrittlement Detector" by E. P. Partridge, C. E. Kaufman & R. E. Hall.

The conclusions drawn from all papers are summarized as follows: Effective chemical inhibition of embrittlement presumably results from the reaction of the treating chemical with the steel surface to produce a protective film. In all laboratory tests reported up to the present the same solution has been used throughout the test period.

Certain tannins, especially those of the quebracho type, will retard embrittlement cracking in test specimens. Relatively low concentrations are sufficient, even at higher pressures. The protective action probably decreases around 500 lbs. per sq. in., although the tannin has been used successfully in several cases at 650 lbs. per sq. in.

Lignins will prevent cracking of test specimens in many boiler waters; they are, however, not satisfactory in some cases. One investigation indicated that their protective action may be increased by the use of a small amount of sodium nitrate, but this needs further study.

No data in the symposium show that sodium sulphate will prevent embrittlement cracking in test specimens, and all data agree that sodium sulphate and sodium chloride do not prevent cracking at pressures above 250 lbs. per sq. in. At lower pressures, no uniform opinion regarding the action of these salts exists.

A boiler water containing sodium hydroxide in appreciable concentration cannot be treated with sodium phosphate to prevent cracking in specimens. Embrittlement can be prevented by eliminating from the boiler water all alkalies that will yield sodium hydroxide when the water is concentrated. The pH in the boiler water is there maintained by the use of sodium phosphate. Simple chemical methods have been developed for controlling this treatment.

Sodium nitrate appears to inhibit embrittlement in the detector tests at least up to 300 lbs. per sq. in. The value of the embrittlement-detector method was practically proven by tests of the Chesapeake and Ohio Railway. Before the application of the detectors between 9 and 21 boilers were found cracked; afterwards between 2 and 6 only were found in an equal time period.

—Trans. Amer. Soc. Mech. Eng., Vol. 64, July 1942, pp. 393-444.

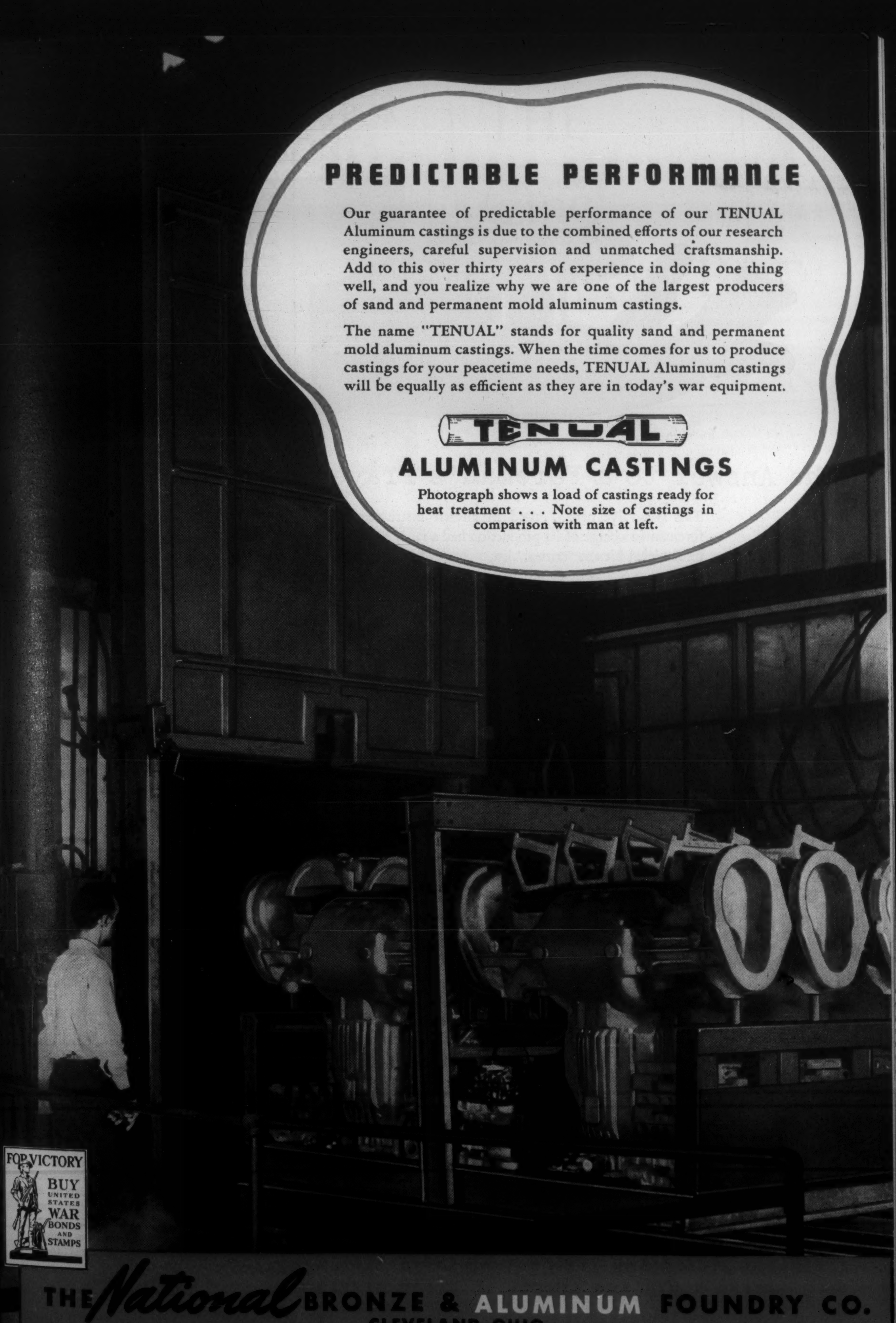
PREDICTABLE PERFORMANCE

Our guarantee of predictable performance of our TENUAL Aluminum castings is due to the combined efforts of our research engineers, careful supervision and unmatched craftsmanship. Add to this over thirty years of experience in doing one thing well, and you realize why we are one of the largest producers of sand and permanent mold aluminum castings.

The name "TENUAL" stands for quality sand and permanent mold aluminum castings. When the time comes for us to produce castings for your peacetime needs, TENUAL Aluminum castings will be equally as efficient as they are in today's war equipment.

TENUAL

ALUMINUM CASTINGS



Photograph shows a load of castings ready for heat treatment . . . Note size of castings in comparison with man at left.

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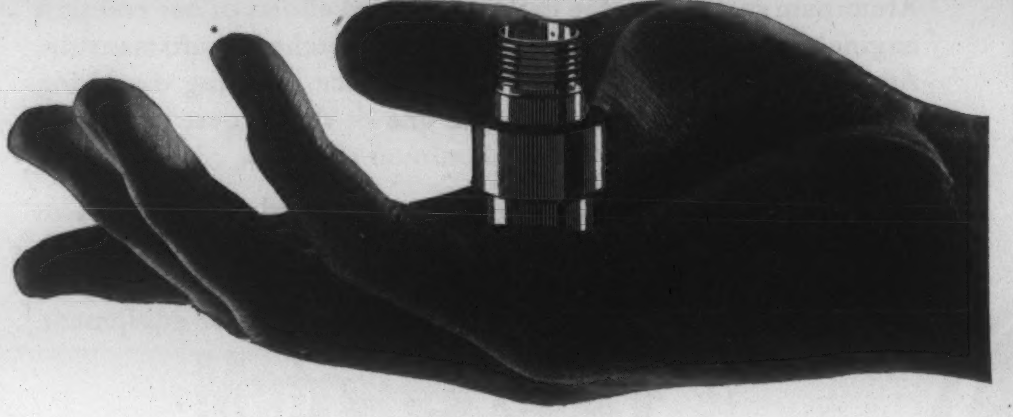

The Answer to a Foreman's Prayer

This is a valve part . . . used in aircraft instruments. The foreman in charge of its production had a fairly happy lot—until nickel hit the "critical" list.

This particular piece was made of alloy steel, rich in nickel. Came a recent day, however, when the specified steel became as scarce as coffee. It looked like production quotas were due to start skidding.

Putting the problem up to Frasse, the foreman substituted, as per recommendation, a more plentiful low-nickel emergency steel—NE 8620. The only wrinkles—slight changes in machining and tempering—were quickly ironed out, leaving hardly a ripple in the production schedule. Trouble hasn't reared its head since.

Frasse technical representatives have been gathering such operating data on the new emergency steels for months. If you are still in the contemplating stage, or have struck a "bug" in changing over, Frasse engineers will be glad to pitch in. Their advice is gratis. Just write or call: *Peter A. Frasse and Co., Inc., Grand Street at Sixth Avenue, New York, N. Y. (Walker 5-2200) • 3911 Wissahickon Avenue, Philadelphia, Pa. (Radcliff 7100-Park 5541) • 50 Exchange Street, Buffalo, N. Y. (Washington 2000) • Jersey City, Hartford, Rochester, Syracuse.*

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COLD ROLLED STRIP AND SHEETS • ALLOY STEELS

Properties of Modern Die Castings

Condensed from "Modern Machine Shop"

The demand for non-ferrous parts makes it necessary to produce them "direct from the ingot," with a minimum of machine work.

Modern die casting products now approach forgings in strength, uniformity, and general utility. X-ray inspection is a common check on quality in the production of aircraft parts from aluminum and magnesium alloys. Rejections are below 1 per cent.

Parts produced by modern super-pressure die casting, at an injection pressure exceeding 20,000 lbs. per sq. in., show a marked gain in density. This is due to greater pressure applied to overcoming resistance to flow as the injection cycle progresses, especially during the final period when rapid chilling is taking place. It is most essential to maintain maximum pressure at the end of the ram stroke.

To prevent the dies from springing apart, a closing pressure of 600 tons must be attained. Incidentally, in this process, flash has been greatly reduced.

More important is the reduction in casting temperatures. In the "Cold Chamber" method the metal can be ladled at close to its melting point, resulting in far less shrinkage and reduced internal stresses. This also minimizes the iron content of aluminum castings.

At the end of the "duration," manufacturers of machinery will use die castings for innumerable parts, including stress parts for which 100 per cent X-ray inspection is essential.

—Fred C. Ziesenheim, *Modern Machine Shop*, Vol. 15, Sept. 1942, pages 154-156.

Cast Iron in Ordnance

Condensed from "The Foundry"

Many uses for cast iron in ordnance have been found and more will be.

Parts formerly made of bronze to prevent freezing on a shaft, because of corrosion, are now made of cast iron with bronze inserts. Bronze gears have been replaced with cast iron. Numerous brackets, pillow blocks, connecting links and similar parts, the use of which made of cast iron, does not sacrifice safety, have already been converted. Others are under test. Most of these are in artillery.

In small arms there are few if any applications, since most parts are subject to severe shock and corrosion. In tanks the use of cast iron is limited because of their rough treatment. There have been a few conversions such as transmission housings.

To date cast iron has not proved effective in either shell or bombs. Except in one test, it has shown poor fragmentation. In some tests, it actually pulverized. Moreover it does not provide the safety against premature explosion given by steel forgings.

—Carl H. Morken, *Foundry*, Vol. 70, Nov. 1942, pp. 73, 164-166.

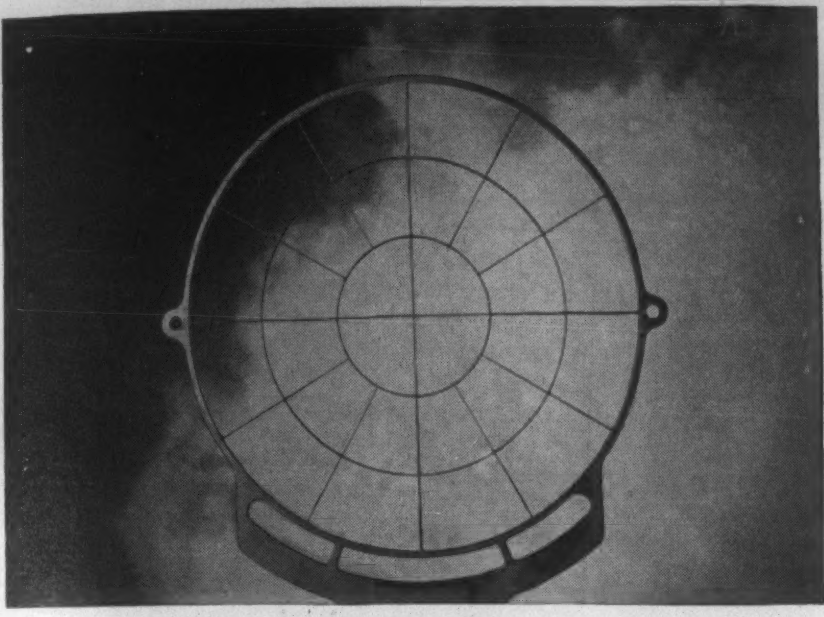
THE New Jersey zinc ALLOY POT

FOR VICTORY
BUY
UNITED
STATES
WAR
SAVINGS
BONDS
STAMPS

A publication issued for many years by THE NEW JERSEY ZINC COMPANY to report on trends and accomplishments in the field of die castings. Title Reg. U. S. Pat. Off.

METALS AND ALLOYS EDITION **No. 3**

DIE CAST GUN SIGHTS FOR THE FIGHTING FRONTS



The cross ribs are under .050″ in section thickness.

All metals and methods of fabrication will eventually find their proper places in the war effort. To the extent that special high grade zinc is available, and with high speed die casting equipment to be utilized for those applications where it can be of maximum value, a wider use of ZINC Alloy Die Castings probably lies ahead.

Our British Allies have, for example, been employing die castings of ZINC Alloy for a variety of war items which are not so produced in this country. Consider the Canadian-made anti-aircraft gun sight shown above. Although the diameter of this gun sight is 11¼″, it has been possible, through ingenious die design, to chase the metal for the cross ribs in section thicknesses which range only .035″ to .050″.

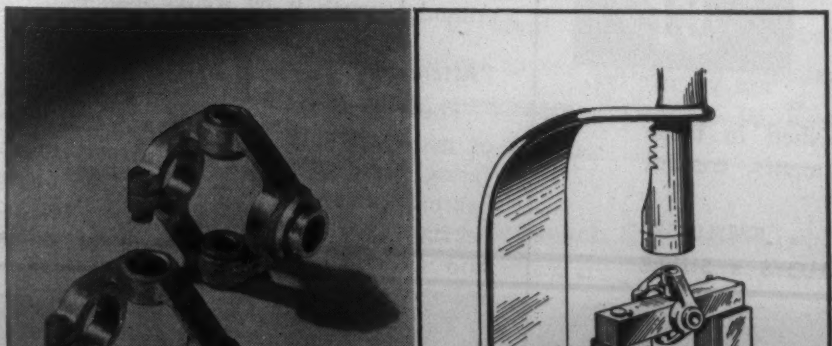
The requirements of dimensional accuracy, production economy and strength for this gun sight all come well within the scope of ZINC Alloy Die Castings.

A CLEVER FIXTURE FOR BUSHING INSERTION

A worker in the assembly department of a Company which uses large quantities of ZINC Alloy Die Castings has developed a clever fixture for bushing insertion. This fixture guards against possible distortion in a thin section of metal, by so supporting the die casting that the stress of insertion is taken by the boss around the bushing hole.

The part in the illustration is a differential gear carrier in the form of a spider. The casting is slipped over a pivoted bar which is swung back against a stop. This bar supports the bushing, flange end down, and holds it in place for the arbor press ram.

Because the bushing, when seated, protrudes above the surface of the casting, a hollow punch is used between the press ram and the casting at the end of the insertion stroke. This punch is placed over a pin next to the supporting block on the fixture when not in use (see sketch).



The fixture guards against distortion and speeds up production of a war item.

THE ECONOMY OF ZINC ALLOY DIE CASTINGS

The pulley hub, the face and the blades of the 9¼″ ZINC Allo Die Cast rotor shown below are all integrally cast. By wha other means could this blower rotor have been produced—i one piece—without costly assembling and machining?

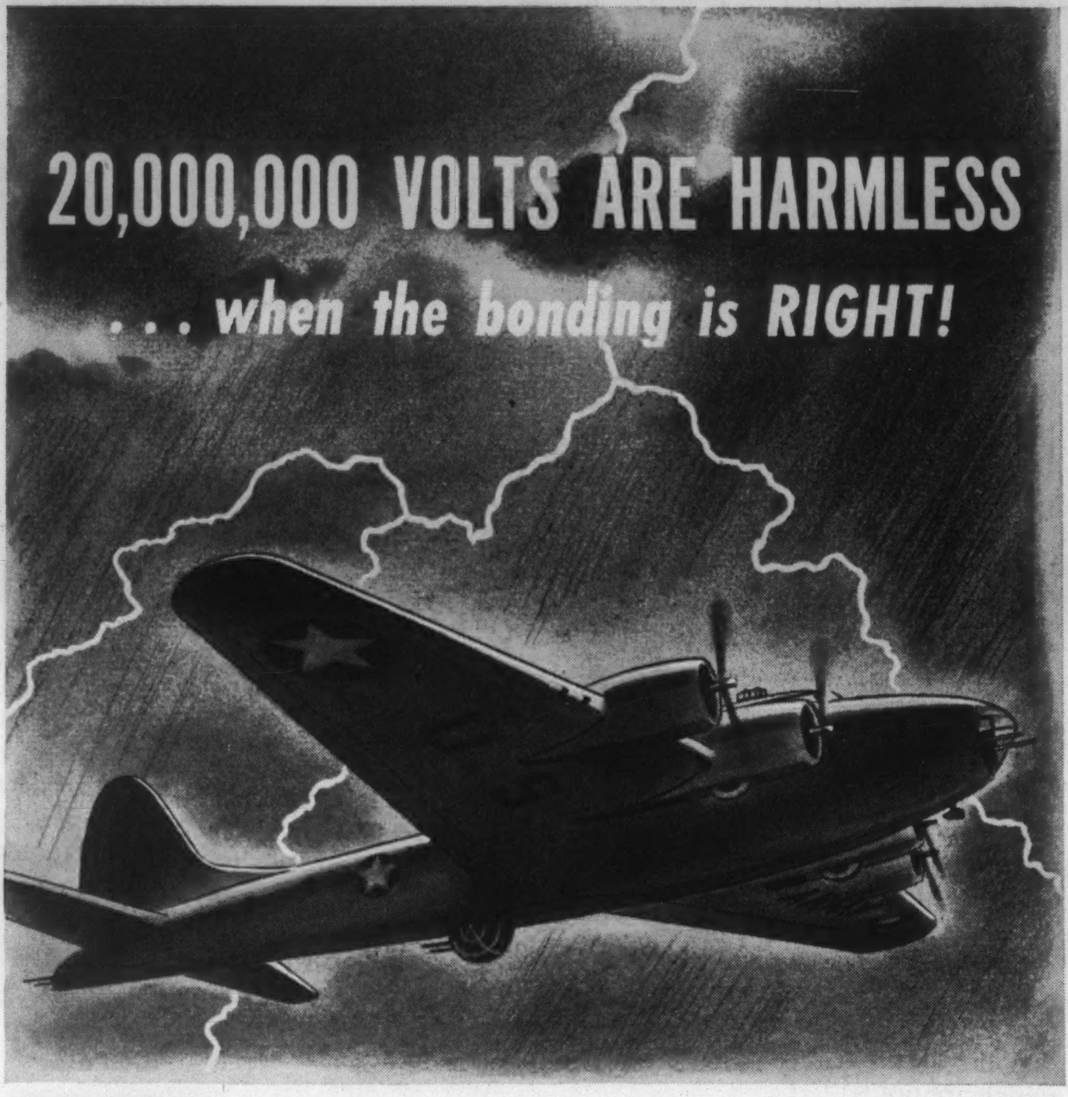
There are many physical reasons behind the adoption c ZINC Alloy Die Castings but, basically, the deciding factor i economy—the material and manufacturing method which wi do the job best at lowest cost.

For further examples of this economy, ask us—on your con pany letterhead—for copies of five booklets illustrating ZIN Alloy Die Casting applications in five major peace-time co suming fields.

Not shown is a metal saver with strengthening ribs—between the hub the largest diameter pulley.

THE NEW JERSEY ZINC COMPANY 160 FRONT ST., NEW YORK C

HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZIN


20,000,000 VOLTS ARE HARMLESS
. . . when the bonding is RIGHT!

CALLITE WIRE used in *Standard Motor Products'* bonding jumpers, handles a complex electrical job when a plane takes to the air.

Protecting the crew against lightning discharges — providing a homogeneous counterpoise for radio transmission and reception — breaking up electrical oscillations in the structural members — forming a low resistance return path for electrical systems — are but a few duties of these bonding jumpers, of which there are from 200 to 1,000 in a single plane.

Naturally, no ordinary wire could turn in such a performance, month after month, under any and all flying conditions. That's why *Standard Motor Products, Inc.* chose dependable Callite wire — noted for its uniform high quality and stamina. If you're seeking precision accuracy in size, temper, tolerance and finish, you'll get them — in plus degree — in Callite wire. Callite Tungsten Corporation, 545 Thirty-ninth St., Union City, N. J. Branch offices: Chicago, Cleveland. Cable: "Callites"

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CALLITE FINE WIRES in sizes as small as .002" furnished in these metals and alloys . . . for springs, control cables, instruments, control devices, bonding jumpers and other applications.

ALUMINUM • COMMERCIAL BRONZE • BRASS — ALL GRADES • BERYLLIUM-COPPER • NICKEL-SILVER • PHOSPHOR BRONZE • SPECIAL ALLOYS • SILVER EVERDUR • STAINLESS STEEL

Callite Wires

A FINE WIRE FOR EVERY NEED

Selecting Bearings

Condensed from "Electrical Manufacturing"

In specifying bearings, speed, load, temperature, operating conditions and character of performance sought should be considered. If the relative motion is sliding, both radial and thrust bearings are plain bearings—when rolling, roller, ball or antifriction.

For Sliding Contact Surfaces

Journal or sleeve bearings consist of a sleeve made in one or more parts usually completely encircling the shaft. They are used in practically every kind of machine, often being found where low first cost and quiet operation are imperative.

There are three kinds of friction in bearings: (1) Dry, when the shaft rubs entirely against the bearing material; (2) fluid, between the oil molecules; (3) mixed or semi-fluid, when the shaft rides partly on the bearing material and partly on oil. Dry friction is the greatest and fluid the least. Seizure may occur with insufficient or improper lubrication.

Hard steel shafts are used with bearings of: Readily-renewable babbitt; bronze, as in machine tools; cast iron, for low cost and light loads; and wrought iron for high pressure and low speeds. Soft steel shafts are used with bearings of white-metal alloys; bronze for strength and good wearing; and cast iron for moderate loads.

Regardless of the size of the bearing, the unit pressure allowed in sleeve bearings of 2 in. diam. or more is low in electrical machinery — about 80 lbs. per sq. in. maximum projected area at full load.

Well bonded steel backed babbitt-type bearings give excellent service where small clearings must be accurately maintained and under heavy pressure. They do not build up excessive temperatures and are adapted for heavy loads and pronounced shaft deflections.

In easily-replaced bronze backed babbitt bearings, the bronze may become the bearing surface if the babbitt wears away. Addition of 20 per cent of free lead to the bronze reduces the danger of seizure.

In sleeve bearings, the rotating shaft is sustained on oil through an oil film drawn around beneath it by wedge action.

"Attentionless" Journal Bearings

These bearings contain a non-dripping or non-contaminating lubricant. Self-lubricating bearings feel the lubricants to the bearing surface as required. The bronze bearings are made porous so as to contain as much as 40 per cent of oil by volume.

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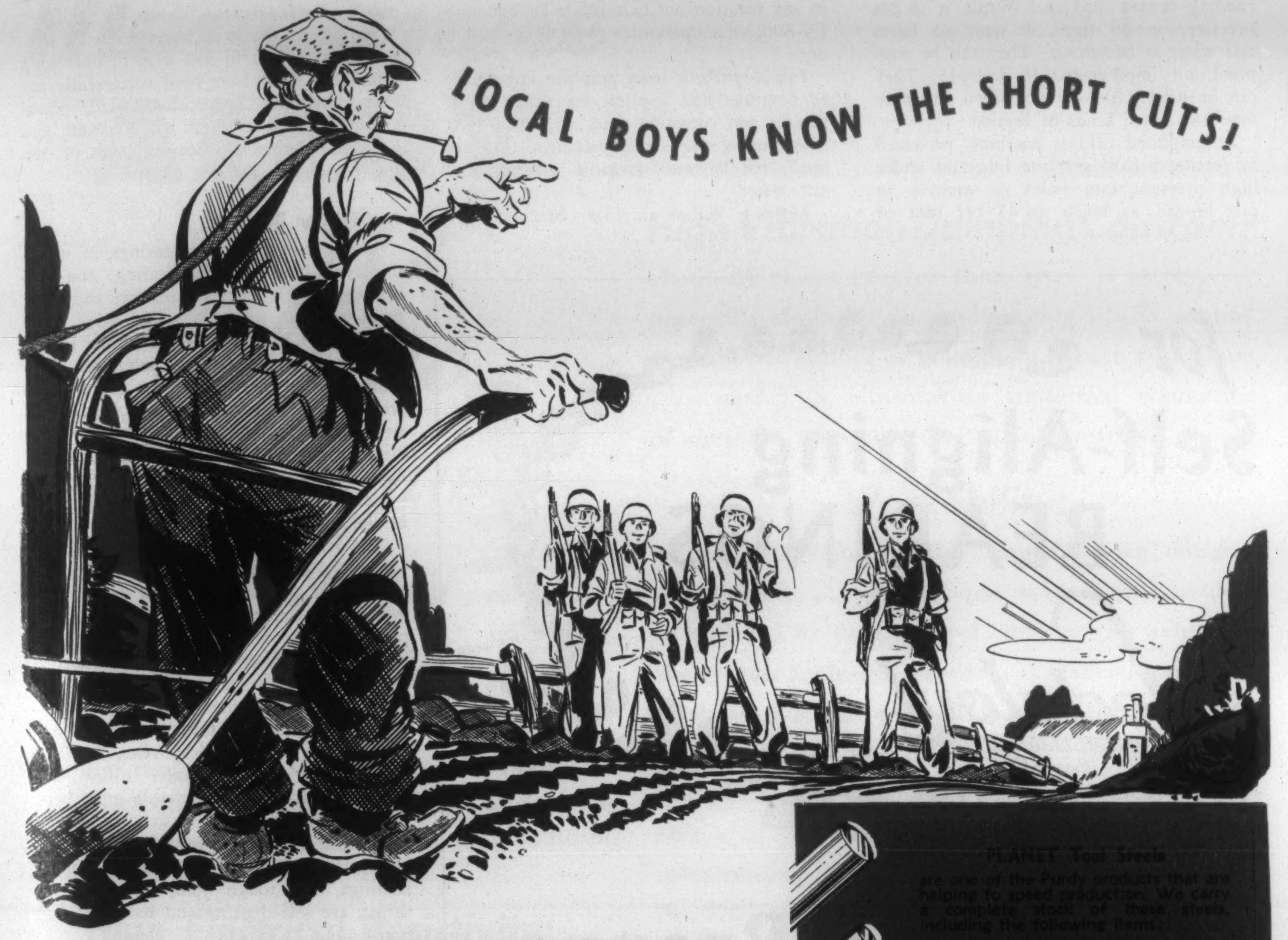

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applications in a dry atmosphere at ordinary room temperature.

Alloy-graphite bearings have an almost microscopic flake graphite so universally distributed that the entire bearing material has as much lubricating value as the rubbing contact surface. While it is not necessary to oil them, it does no harm and water is beneficial. They can be supplied, oil impregnated if desired. They can be used with, or submerged in, more than 180 listed kinds of liquids.

In graphited oil-less bearings, produced by forcing a hard graphite lubricant under high pressure into holes or grooves in cast bronze, as much as 45 per cent of the total graphite surface is in contact with the shaft. Special babbitts are also used instead of bronze.

Hard rubber and graphite form a bearing material which is operated dry at low speed and low pressure with PV-200, and in any solution not harmful to rubber with PV-600, at temperatures not exceeding 250 deg. F.

Fabric-synthetic-resin graphite impregnated bearings find applications where wear, neglect and corrosion tend to prevail. At conservative speeds and pressures, they are unaffected by most organic solvents and salt water.

Molded carbon-graphite bearings are based on pure, soft, and non-abrasive graphite bonded with carbon. They can be used wet or dry with any liquid from water to gasoline as a lubricant. They will not shrink, warp, melt or scale and are electric and thermal conductors, yet excellent refractories.

No added lubricant is necessary at temperatures of 300 to 350 deg. F. over long intervals. They have been successfully operated in pure hydrochloric acid, potassium dichromate, sodium hyperchlorate, and hydrogen peroxide. Bearing loads of 500 lbs. per sq. in. are not unusual.

Anti-Friction Bearings

These comprise roller bearings, of which one type is the needle bearing, and ball bearings which include miniature and pivot types. Both include self-aligning and thrust types. The rollers and balls are of hardened steel, ground and polished. They must exactly conform to the surfaces on which they roll, and the latter must be in substantially perfect alignment with proper clearances. They require lubrication. Because the consistency of the lubricant is important, a variety of closure designs are available.

The friction, in roller bearings, remains substantially constant at all speeds when no end thrust exists. Restraint of endwise motion is accomplished by the use of end plates or by countersinking the races. End thrust is largely overcome by designing so that the end thrust of one roller tends to neutralize that of the other.

In double-row cylindrical bearings, designed for machine tool spindles, the large number of straight-cylinder rollers and the long roller contact provide great bearing rigidity and high capacity. Due to small temperature rise more accurate work is assured. Double-row spherical roller bearings, for tough jobs, take two-way thrust, are self-aligning and have low friction.

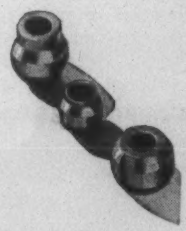
Needle bearings are roller bearings with small diameter rollers which cause an increase in the number of rollers for a given shaft diameter and a decrease in the diameter of the entire bearing. Variations are the use of rolls alone, without auxiliary races or constraining members; a type comprising heavy through-hardened races with retaining shoulders or rings; and a unit type comprising a thin cylindrical shell surrounding and retaining the rolls.

Loose-roll bearing applications are found almost exclusively in the automotive industry. The unit type is designed for general use. It has about the same static as running friction.

Housings should be so designed that heavy radial loads on the bearings are transmitted directly to the wall or rib support of the housing. A lubricant must always be present between the rolls and the shaft.

Ball Bearings

Ball bearings operate in all positions without changes in the relative position of shaft and bearing. They have no inherent tendency toward end thrust. They require only a narrow bearing seat and are available with sealed-in lubricants and protection through end-closures.



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1050 ohms per circular mil foot, or about 60% higher resistivity than most alloys now in common use . . . not affected by annealing, cold working, or cooling to—100°F. This alloy is ideally suited for low temperature resistor applications, rheostats, circuit breakers, and other electrically heated elements.

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Low Thermal Conductivity:

only 2% that of copper. Brackets of this alloy, carrying bimetal circuit breaker elements, have acted as barriers to reduce heat losses by 50%.

High Vibration Damping Constant:

about 25 times greater than that of steel . . . especially desirable in applications which cannot incorporate rubber or plastics to reduce vibrations . . . useful in eliminating sustained resonance of metallic members due to intermittent shock.

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can be readily machined, stamped, drawn, flanged, or extruded . . . it can be spot welded, butt welded, or soldered to itself or steel, or it can be welded by the atomic hydrogen process . . . Chace Manganese Alloy No. 772 is now available in the form of sheets, strips and rod, and in special shapes on request. Complete engineering and research facilities available . . . "Bulletin No. A-942" giving detailed information regarding Chace Manganese Alloy No. 772 sent on request.

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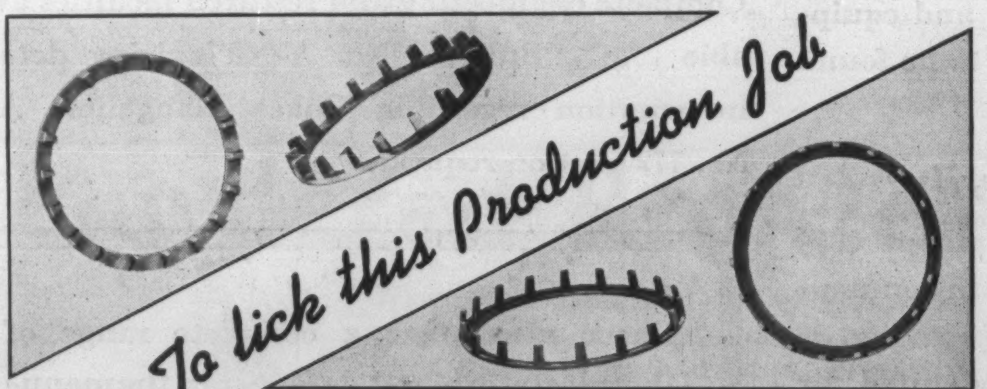

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A two-row ball-bearing with a spherical inner surface of the outer race embodies the self-aligning feature for compensating for unavoidable conditions of misalignment due to shaft deflection or frame distortion, without impairing its full carrying capacity.

In ball bearings friction is independent of speed and temperature, varies directly as the load, and is not materially reduced by lubrication. The static friction is but slightly greater than the running friction.

Split ball bearings appear at such specification points as crankshafts, hangers, and pillar blocks.

Miniature precision ball bearings are designed primarily for use in fine mechanisms and instruments of precision subject to severe shocks or jolts. Their high load capacity makes them suitable for applications where jewel pivots sufficiently small to have anti-friction properties, do not possess sufficient strength, and where operating speeds are too high to permit the use of jewels of adequate size. They operate without lubrication.

Self-aligning pivots are available as anti-friction bearings to replace jewel pivots where the strength of the latter is insufficient, in a proper size. They are commonly used in opposed pairs with an end play of a few mills. Dry running is possible where required but a light grade of mineral oil should ordinarily be used.

—Charles R. Underhill, *Elec. Manufacturing*, Vol. 30, Nov. 1942, pp. 43-46, 112-122.

Columbium in High Temperature Steel

Condensed from "Metallurgia"

In recent investigations, E. R. Parker has found that certain intermetallic compounds are more stable at high temperature than carbides; and that alloys containing precipitates of such compounds possess a greater resistance to deformation and fracture than commercial alloys, relying upon carbides for their strength. His experiments with a 3 per cent Cb, 97 per cent Fe alloy are noteworthy. Similar investigations in Germany have resulted in the development of low-alloyed columbium steels for high-temperature service.

Iron-columbium alloys with more than 0.5 per cent Cb can be hardened by quenching from high temperatures and subsequent tempering, because the solubility of the intermetallic compound formed increases with rising temperature. Tests with an alloy containing 1.9 per cent Cb show that hardness rises steeply from 900 deg. C. (1652 deg. F.) and declines at temperatures exceeding 1150 deg. C. (2102 deg. F.). This is due to the different solubilities of columbium in the gamma-phase and the alpha-mixed crystal and in the gamma-alpha transformation after quenching, and the fact that at 1150 deg. C. (2102 deg. F.) the alloy enters the delta-phase and that the homogeneous delta-mixed crystal is not subject to transforma-

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AUTOMATIC TABLETTING EQUIPMENT

tion during quenching to room temperature.

In testing the influence of the temperature of draw upon the hardness with various temperatures of quench, it was found that the optimum precipitation temperature lies between 600 and 650 deg. C. (1112 and 1202 deg. F.) and that, a 1300-deg. C. (2372 deg. F.) quench obtains the greatest hardness.

This property of columbium finds extensive employment in stainless chromium-nickel steels where its addition reduces the danger of intercrystalline corrosion. It can also be used to reduce the hardness of chromium steels which must not be hardenable. Columbium, to eight times the carbon content is required for combining the carbon content.

With a steel containing 0.13 per cent C and 1.04 per cent Cb, the hardness can be increased from 87 to 99 Brinell with quenching from 1100 deg. C. (2012 deg. F.) Quenching from 1200 or 1250 deg. C. (2192 or 2282 deg. F.) shows still greater hardness. Columbium carbides brought into solution at high temperature are precipitated only with the temperature of draw exceeding 500 deg. C. (932 deg. F.) Decrease in hardness occurs only when a temperature of 650 deg. C. (1202 deg. F.) is exceeded.

This high resistance to tempering can also be produced with steels in which the columbium percentage is more than eight times that of the carbon. When the columbium carbon ratio exceeds 8:1, the creep strength shows a rapid rise, due to the existence of the intermetallic compound of iron-columbium in addition to the columbium carbide.

Impact strength rises with tempers at 550 deg. C. (1022 deg. F.) and higher but above 550 deg. C., creep strength rapidly decreases. Increased yield point and creep strength, therefore, must be purchased at the expense of notched-bar impact strength. Impact tests on plain bars without notch showed good impact values.

The same heat treatment can be applied to alloyed steels if the columbium content is higher than 8 times the carbon percentage.

Additions of columbium, with columbium more than eight times greater than carbon, to austenitic high temperature resistant steels, results in improvement of creep strength. Addition of columbium beyond a certain upper limit effects changes in the structure of highly alloyed chromium-nickel steels. Restitution can be effected only by increasing the nickel content. Existence of the critical 8:0 ratio was also found in the case of rolled material not subjected to heat treatment.

Any increase in columbium above 2 per cent is useless as it will not be accompanied by further improvement in creep strength. Less than 2 per cent permits the use of high quenching temperatures without producing the delta-crystallites. A reduction in columbium content to 1 per cent will not effect a reduction in creep strength, provided the carbon content is also reduced to the greatest possible extent. The favorable influence of increased carbon content in steels containing 2 per cent Cb and more is solely due to the fact that it tends to shift the gamma-delta transformation to higher temperature ranges.

Minimum permissable columbium content lies between 0.5-0.7 per cent. Erratic decreases in creep strength in steels containing less than 0.5 per cent Cb showed the beneficial effect of the intermetallic compound was negatived by some factor which was finally found to be the sulphur content. A reduction of sulphur to 0.01 per cent, which can be achieved by special methods, results in only a slight reduction in the creep strength qualities.

—D. W. Rudorff, *Metallurgia*, Vol. 26, Oct. 1942, pp. 193-196, 224.

Nickel Alloy Springs

Condensed from "Wire and Wire Products"

High-nickel alloys are useful in many elevated-temperature spring applications since they retain their strength to a considerable degree at elevated temperatures and resist oxidation and corrosion. The authors, in cooperation with the A.S.M.E. Special Research Committee on Mechanical Springs, have undertaken to supply accurate laboratory data for Monel, "K" Monel, "Z" nickel and Inconel.

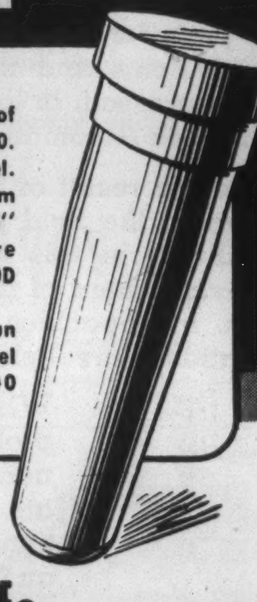
The term "relaxation" is used to denote load loss occurring, at constant height, in

OUTPUT per punch UP 250%

CASE J143

Expanding punches of Ampco Metal Grade 20. Previously used steel. Nickel molybdenum rings 2.62" OD x 1.355" ID x .36" long were expanded to 2.95" OD x 1.91" ID

Result: maximum run of 3000 rings using steel increased to 10,500 using Ampco Metal



AMPCO Expanding Punches Have Longer Life

Again "Ampco" bronze proves its worth — this time in expanding punches. Here centrifugally cast Ampco Metal Grade 20 was used to expand nickel molybdenum rings, increasing OD .35" and the ID .553". Service life of Ampco punches was 3½ times that of hardened steel.

Ampco Metal Grade 20 has the necessary hardness — 212-248 Brinell for this application. Its strength and resistance to high compressive loads are other necessary factors in successful service. As many engineers know, it is the only copper base bearing alloy with these requirements. By using Ampco, you avoid metal weakness, failure and frequent replacement.

Ask for Data Sheet 100, describing the use of Ampco Metal in expanding punches.

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"All-out" wartime production has made metals hard to get. Many manufacturers today are thinking in terms of replacing habitually used corrosive—weighty—costly materials . . . with NON-metallics.

Many of these change-overs will so improve products . . . and will be found to be so superior to the materials formerly used . . . that designers will never go back to the "horse-drawn cannon days."

Furthermore, a golden opportunity now exists for designers and engineers in C-D NON-metallic products. You who have been wanting to design new modern materials into your products can *now* do so with full approval of management.

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closely coiled helical compression springs. In this case elastic strain in the outer fibers, produced by the external load, is converted to plastic strain, or permanent set. The amount of recoverable strain is thereby reduced and there is a proportionate reduction in the load supported by the spring. The percentage loss from the original load is expressed as "per cent load loss" or "per cent relaxation."

Conclusions are based on tests of springs loaded to a constant height, but within stress and temperature limits which would produce not more than about 10 per cent relaxation, these data could be applied to cases of constant-load service also.

Description of Springs

The springs tested were of 0.148-in. dia. cold-drawn wire, 1¼ in. OD. 2¾ in. free height and had 6¼ total coils and 4¼ active coils. After coiling, ends were ground flat for 270 deg. They were given a thermal treatment before testing. Monel and Inconel were given low-temperature stress-equalization anneals, while "K" Monel and "Z" nickel were heat-treated.

On the basis of preliminary tests all Monel springs were given a 650 deg. F. stress-equalizing anneal for 1 hr. and all Inconel, the same at 900 deg. F. All "K" Monel springs were given a heat-treatment of 1000 deg. F. for 6 hrs. followed by 900 deg. F. for 16 hrs. All "Z" nickel springs were aged at 900 deg. F. for 6 hrs.

It was found that a 7-day period was the necessary duration of exposure to insure that practically all the relaxation had occurred.

In performing these tests, the loads required to produce the desired stresses were applied to the springs in a weighing attachment mounted upon a Toledo scale, with 1 oz. sensitivity. The loaded length of each spring was measured to 0.001 in. The spring was then compressed to the measured loaded length and held there upon a special bolt and nut. The bolt was of ⅞-in. dia. Monel to avoid creep. Washers, larger than the outside diameter of the test spring, were welded to the head of the bolt and the nut.

Sixty springs, thus assembled, were placed in a nickel box in an electrically heated oven for the heating period. A temperature uniformity of 3 deg. F. existed throughout the box and temperature control within 5 deg. F. was maintained.

After seven days, the springs, taken out and cooled in air, and having the holding bolts removed, were compressed to original loading strength. The load supported after test was measured. The difference between this and the originally applied load is the basis of the "load-loss" calculation.

Conclusions

Results of the tests, charted in the article, lead to the following conclusions:

1.—Inconel resists relaxation up to high temperatures and may be used at high stresses up to 650 deg. F. Above this temperature the stress must be lowered considerably and a slight degree of relaxation must be tolerated.

2.—"Z" nickel and "K" Monel will withstand higher stresses than Inconel at the lower temperatures, consistent with their generally higher level of mechanical properties.

3.—"Z" nickel may be used with high stress at temperatures up to 550 deg. F. and with reduced stress up to 600 deg. F.

4.—"K" Monel may be used with high stress up to 450 deg. F. and with reduced stress up to 500 deg. F.

5.—Where other factors such as corrosion resistance are involved, Monel offers possibilities as a spring material for temperatures up to about 400 deg. F. and at moderate stress levels.

6.—Monel springs should be stress-equalized for 1 hr. at 650 deg. F. where relaxation resistance is desired.

7.—Inconel springs should be stress-equalized for 1 hr. at 900 deg. F. for service at elevated temperatures.

In applying these data to design, the size and strength of the wire used should be remembered. While the tensile properties were typical of those obtained in 0.148-in. dia. wires of these alloys, they cannot be assumed as minima. Also these materials, especially Monel and Inconel, show lower tensile strengths for larger diameters. However the data should be representative for all wire diameters up to about 0.148 in.

—B. B. Betty, E. C. MacQueen, and Carl Rolle, *Wire and Wire Products*, Vol. 17, Nov. 1942, pp. 653-661.

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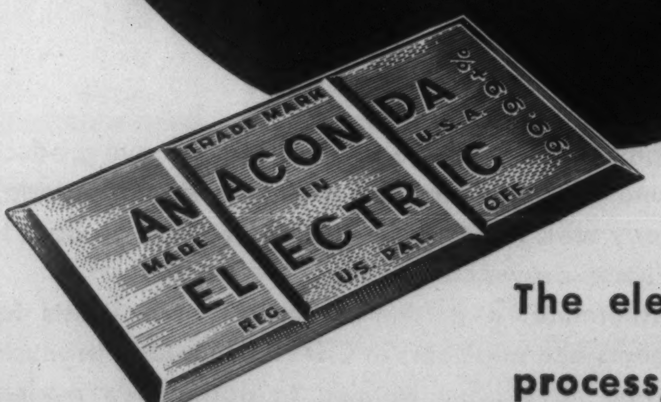

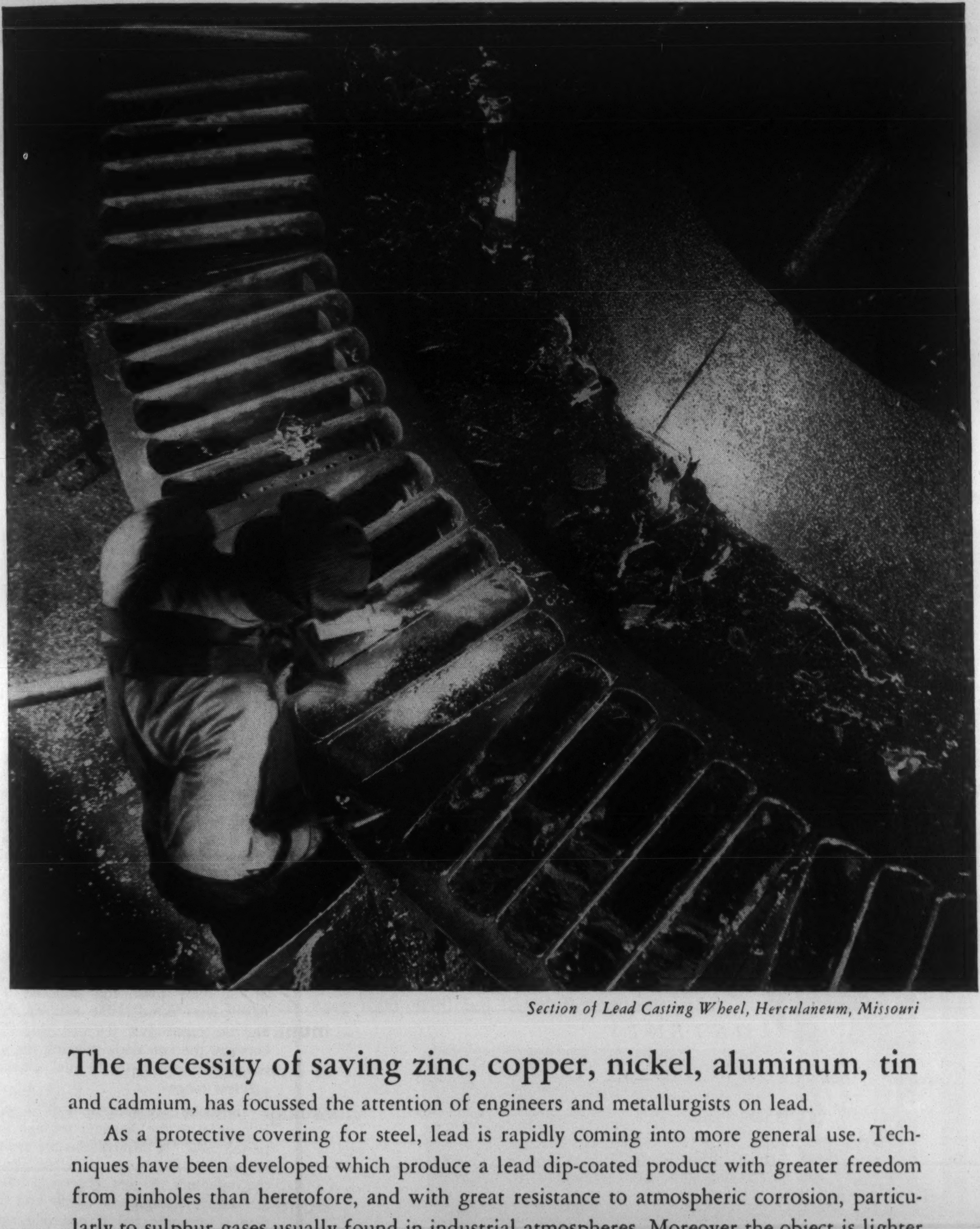

Section of Lead Casting Wheel, Herculaneum, Missouri

The necessity of saving zinc, copper, nickel, aluminum, tin and cadmium, has focussed the attention of engineers and metallurgists on lead.

As a protective covering for steel, lead is rapidly coming into more general use. Techniques have been developed which produce a lead dip-coated product with greater freedom from pinholes than heretofore, and with great resistance to atmospheric corrosion, particularly to sulphur gases usually found in industrial atmospheres. Moreover the object is lighter in weight than the same object galvanized. In dip-coating with lead there are no dross losses and the pots last longer than when used for galvanizing. While pure lead can be used for this process, the addition of a small amount of antimony or tin, or both, is beneficial.

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Detection of Flaws in R. R. Axles

Condensed from "Engineering"

Wheel-seat flaw occurs usually just within the fit. It has the great disadvantage of causing the external trace of crack to be completely hidden from visual inspection. In some cases where the flaw lies just at the edge of the fit the external trace of the crack is inaccessible and covered with dirt and cannot be seen without removing the wheel.

Description of the Apparatus

The apparatus eventually developed for measuring wheel seat flaws consists of 3 stiff radial arms, spaced at intervals of 60 deg., carried by a stout ring which is split diametrically, two halves being connected by long bolts after the ring is placed around the axle. The ring grips the axle by 3 ball-ended seats.

The ring is mounted parallel to the wheel and a short distance from the inner face of the wheel-boss by 3 screws; these are in place during adjustment and are withdrawn after the ring is secured, so that the radial arms are effectively upon the axle alone. The outer end of each arm has a dial gage, sensitive to 0.0001 in. To avoid errors due to the rough surface of the wheel, small discs of smooth metal are stuck to the wheel to form a footing for dial gage plungers.

The axle is rotated by power operated rollers. Rails are cut away for about a foot on each side and in each gap is placed a pair of rollers. Each roller is driven by a 1 h.p. three-phase motor through a 1/60 reduction gear.

The process is as follows: The ring is fixed to the axle at a random angular position relatively to the axle. Dial gages are adjusted and the range of reading is observed during one revolution of the wheel. If three ranges are close, usually 0.001 in., then there is no flaw — that is, if the apparatus is set up properly.

A check is made by repositioning the arms and reading the dials. If the ranges of the dials differ, this indicates that the flaw passes through the axis of the axle, and the centroid of the suspected flaw lies between the two dials showing the greatest range, and closest to the dial showing the greatest range.

The arms are repositioned so that one is parallel to the diameter through the suspected flaw. If observations are again haphazard and the ranges in close agreement, the inference is that observed differences are due to background effects and that no flaw is present; but if one dial shows a greater range than either of the others, indications of flaw are confirmed.

A further test may be made, based on readings of the second test. One arm is placed along the diameter of the flaw, but pointing in the opposite direction. This third test is not necessary with large flaws.

Normal ranges for sound axles of vehicles having 2, 3 or 6 axles will differ, if they carry different loads from those of standard 4-axle bogie stock. Also normal deflection ranges will vary with the diameter of the axle, and will differ according to whether the wheels have spokes,

HIGH TEMPERATURES

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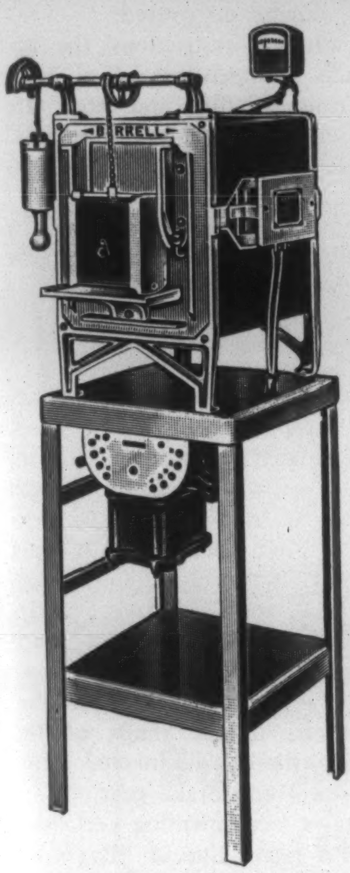
for temperatures up to—

2550° F

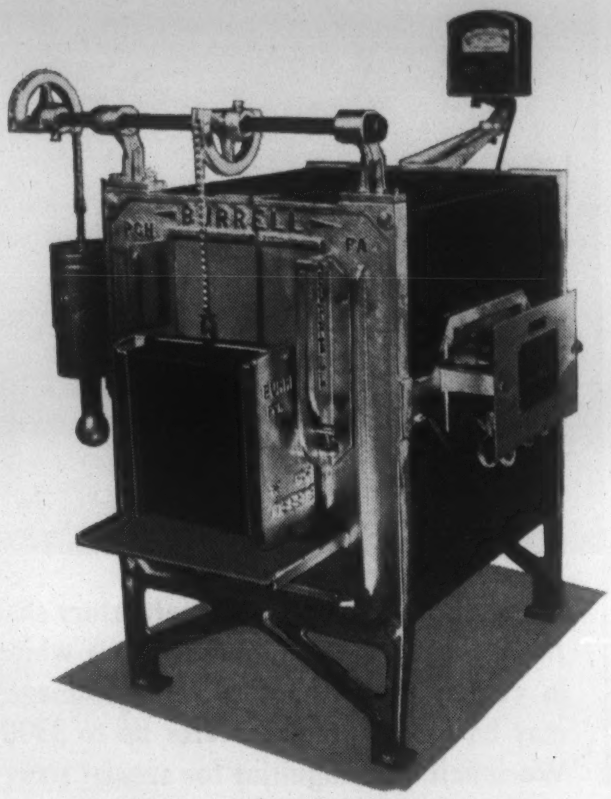
Tube Furnaces—up to 2650° F



The heating chamber measures 4″ x 4″ x 13¼″ deep including 4¼″ throat. The floor is a removable, refractory plate with moulded sides to prevent spillage from reaching the insulation. Overall outside dimensions of the furnace are 26″ wide x 30″ high x 24″ long.

The heating elements are designed to give long life but when it is necessary to replace them this operation can be done in a few minutes without cooling the furnace.

Other standard models include muffle types—combustion tube types—and pit types. Ask for Burrell Catalog F-241.



A37-440 Burrell Type K Furnaces have been found convenient for all manner of heating operations in laboratories and pilot plants.

BURRELL **TECHNICAL SUPPLY COMPANY**
1936-42 Fifth Ave. Pittsburgh, Pa. U.S.A.

DIRECT REPEATED STRESSES

May be applied to riveted joints, spot welds, cap screws or similar fasteners in this machine where laboratory tests may be made to approach actual service conditions.

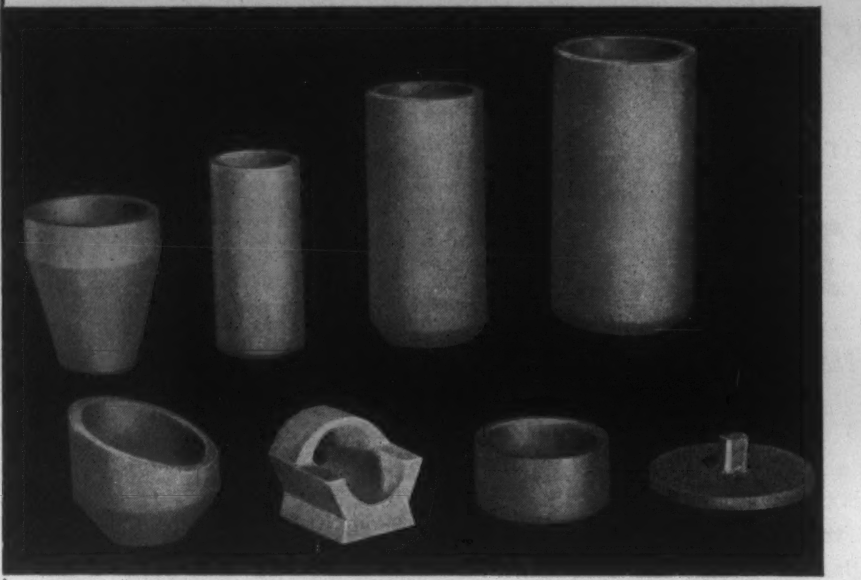
This machine uses a flexible lever as the load applying and measuring means. Flexure plates act as frictionless bearings assuring axial loading through a parallelogram system. Three sizes of machines have 1000, 4000 and 10,000 lb. capacities, each unit testing two independent specimens at once.

Write for the new catalog describing our complete line.

TESTING SERVICE

More than 10 years of experience in design and testing of repeated stress machines has given us valuable information for the solution of fatigue problems. We have equipment for making routine or special repeated stress tests and should your problem require a special testing machine our design and manufacturing facilities are available at all times.

KROUSE TESTING MACHINE COMPANY
573 EAST ELEVENTH AVENUE COLUMBUS, OHIO



DO YOU NEED A CRUCIBLE THAT CAN TAKE A BEATING?

Wesgo crucibles and other refractory shapes will not crack or spall under the most severe conditions. Thus a white hot crucible may be "dunked" in cold water without suffering damage. Various shaped crucibles that may be used at temperatures up to 3300 degrees F., are stocked.
We solicit your inquiries for special sizes and shapes as well as our stock sizes of crucibles and other refractory articles.

WESTERN GOLD AND PLATINUM WORKS
589 Bryant Street San Francisco, Calif.

Leitz Metallographic Table Microscopes

(Made in U. S. A.)

with large Vertical Illuminator, mechanical stage with rack and pinion, magnifications 30 - 1200 x low voltage lamps. Photomicrographic cameras. Available for immediate delivery. Detailed information on request.

G & D pH Automat

The self-contained pH - Meter with electronic and automatic compensation. For laboratories and plant control work.

pH measurements and recording, oxidation reduction and neutralization titrations, m.v. measurements. Write for new pamphlet M. 2 and list of users.

Gamma Instrument Co., Inc.
95 Madison Ave.
New York, N. Y.

steel disc or wood centers, and whether bands are shrunk-on or rolled integral with disc centers.

The apparatus does not distinguish between wheel-seat flaws and other defects that cause exceptional deflection between the wheel and the axle. Any flaws revealed by this apparatus, even in mistake for axle flaws, can be discovered.

Owing to wartime restrictions the apparatus is made of steel instead of light alloy. The ring is solid and arms are welded of plate $\frac{1}{8}$ in. thick. The total weight is 28 lbs. The test is made in $2\frac{1}{2}$ hrs., if the axle is sound.

This seems to be the first method by which a concealed wheel-seat flaw can be discovered with mechanical instruments.

Applications

An axle found flawed revealed good mechanical properties, when actually tested. Specimen taken from a position $\frac{3}{4}$ in. from the surface showed: Tensile strength 83,000 lbs. per sq. in.; yield stress 53,000 lbs. per sq. in.; yield ratio 63 per cent; elongation 32 per cent; and reduction of area 63 per cent. Chemical analysis was satisfactory and Baumann print showed no sulphur segregation. For testing the middle axle of a 6-wheeled car, slight modifications in the shape of the arms is necessary, due to diminished clearance between wheel and brake gear.

E. W. Davies, commenting on this development in a later issue of *"Engineering"* (Sept. 11, 1942, pp. 215-216) states that the operation of the apparatus is simpler than claimed, though time consuming.

As to the nature of the flaws nearly all axle fatigue failures fall into one of two types;

(1) Fatigue flaws in the body of the axle — these are of the corrosion fatigue type. Prevention of corrosion by means of a suitable protecting coating would eliminate them without any increase in weight. Corrosion fatigue failures are practically unknown on British railways.

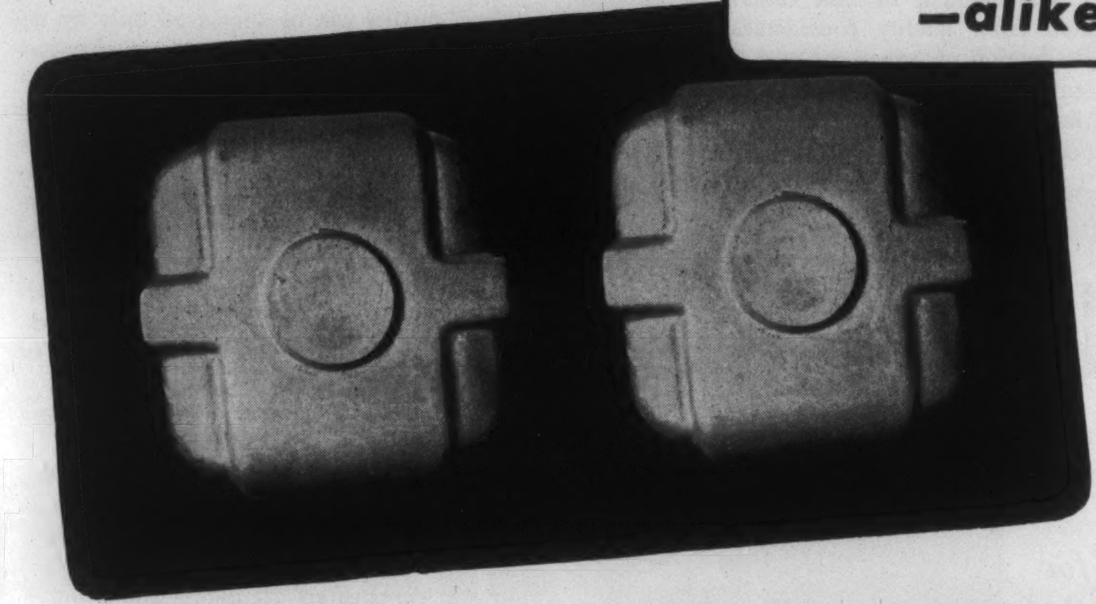
(2) Fatigue flaws at or just within fit of the wheel hub on the axle — these are obscured by the hub and are particularly dangerous and almost all accidents caused by axle breakage have been due to the growth of fatigue flaw of this type. The fundamental point is that the fatigue strength of axles when considered in relation to the service stresses is least at the wheel seat.

Wheel seat flaws are caused by the effect of shock-loading in service combined with a concentration of stress which occurs in the vicinity of the edge of the press fit. Bending moments and corresponding stresses in the axle due to the weight of the vehicle when standing or rolling on a straight track are small. Bending moments of three or four times this amount occur near the wheel seat for short periods, as a result of flange blows at curves, switches, crossings, etc., and it is these that cause the highest stresses in service.

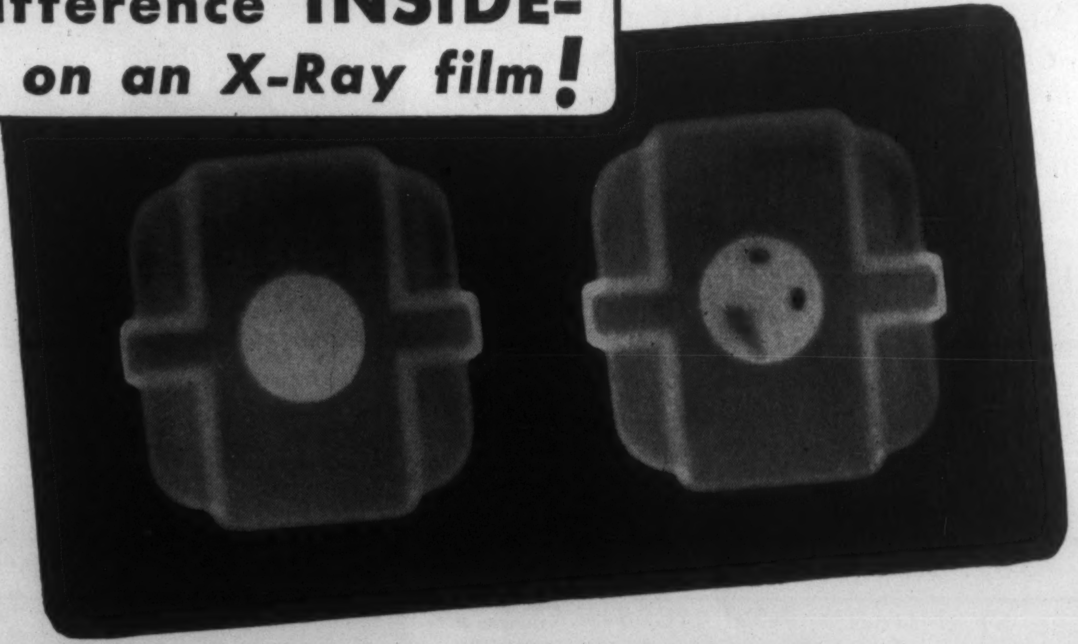
Radial pressure of the hub induces longitudinal as well as radical steady stress in the wheel seat near the end of the fit; and the local pressure and frictional forces

The X-Ray Story of
TWO CASTINGS!

From The OUTSIDE-
—alike as two peas!



But what a Difference INSIDE-
as shown on an X-Ray film!



KELEKET X-RAY

INDUSTRIAL X-RAY

THESE pictures tell an amazing story. At the top are shown two castings both from the same mold — apparently identical and both acceptable upon a surface inspection.

However, X-ray inspection shows that one is free from defects and practically perfect, but the other shows gas pockets which should mean immediate rejection! Thus, X-ray inspection saves costly machining as well as the possibility of an expensive break-down in use.

KELEKET Industrial Units are now being used by many industrial plants for making X-ray inspection radiographs—both in the laboratory and in the production line. Harnessed to war production, these units save time and money — and improve quality!

There is a KELEKET X-ray machine for every industrial use, from the inspection of the lightest aluminum sheets up to 5-inch steel, and these machines will detect flaws as small as 1% of material thickness.

Consult KELEKET engineers for information concerning X-ray inspection for your requirements.

THE KELLEY-KOETT MFG. CO., Industrial Division, 220-1 West Fourth Street, Covington, Ky.
Representatives in 64 Cities

PIONEER CREATORS OF *QUALITY* X-RAY EQUIPMENT SINCE 1900 which arise between the hub and the wheel seat when a temporary bending moment is applied to the axle by a blow on the wheel flange, cause the stresses near the end of the wheel seat to be higher than the simple bending stress alone. Therefore, the weakest part of the axle is just within the wheel fit.

Davies reports experiments conducted on press-fitted assemblies, which showed that press fit reduces the fatigue strength of axles from 45 to 65 per cent, and have indicated a number of ways by which this weakening may be eliminated. The more promising methods appear to be local strengthening of the material at the wheel seat only by surface rolling or flame hardening, or by locally reducing the stresses in the wheel seat by increasing the diameter of the part of the axle only by a sufficient amount.

—F. C. Johansen, *Engineering*, Vol. 154, Aug. 7, 1942, pp. 101-104.

Quality Control of Munitions

Condensed from "Army Ordnance"

The element of risk cannot be eliminated from quality considerations in mass production of armament and the real problem is how to reduce to a minimum the chances which must be taken without impeding output. Determination of the presence, in ordnance matérial, of many defects which will cause dire results, often requires test and inspection procedures which are themselves destructive. Even where they are not, "inspection fatigue," prevents perfect insurance of conformation to specifications.

Quality Control at the Operation

Quality-control techniques are built around limiting such risks to a predetermined degree. In mass production, or where quality can be measured only by destructive or qualitative tests, quality-control techniques are the only adequate assurance of quality, and quality control is impossible without properly planned inspection arrangements on a statistically sound sampling basis. Conversely any inspection plan is inadequate without sound statistical quality-control techniques.

Perhaps the most important characterisic of quality control under present conditions is that without it a greater amount of testing and inspection is required, and it is increasingly difficult to secure satisfactory inspectors and testing equipment.

If the right factors are selected for control watching, the mechanics of the plan so arranged that necessary computations, platting of inspection results, etc., are carried out and conclusions accurately and promptly drawn, quality control will focus a spotlight on unfavorable conditions before evidence would otherwise be available. In this way during the course of manufacture, production of quantities of defective work can be avoided and testing and testing-equipment time and material can be conserved. Inspection becomes a boost for output, not a hindrance.

The Ordnance Department offers its contractors every encouragement to attain such control, short of actually aiding. It will advise with the manufacturer and make available to him all levels and trends in his quality evidenced by Ordnance inspection results.

Evidence that quality is acceptable, provided by control at a satisfactory level, is a sound basis for reduction of acceptance inspection. This cuts down the amount of finished product waiting inspection, eliminates storage, reduces the manufacturer's inventory, and enables him to get his money back more quickly.

Quality control requires a tailor-made plan to fit each type of product and each set of production conditions and should take advantage of every ingenious device which can be brought to bear from local production conditions.

Acceptable Quality Level

The first step is the determination of the "process-average-quality," or the quality of the material actually being turned out under normal conditions of satisfactory operation. It may be expressed as the normal per cent defective of the product as a whole, as the normal measured value of a particular characteristic quality such as length in inches or tensile strength in pounds per sq. in. Determination ordinarily requires inspection, measurement, or test of fairly large and well-distributed samples over a representative period.

The next step requires fixing the "acceptable-quality level," in the same terms as the process average, for direct compari-

AB Specimen Mounting Press No. 1315
AB Standard Polisher No. 1500
Adolph I. Buehler

METALLURGICAL TESTING EQUIPMENT

Especially designed and engineered for the rapid, precision, testing of metals.

NEW SPECIMEN MOUNT PRESS—Constructed with a rugged simplicity that will give long service, and precision built for accuracy. The molding tools are lapped finished for close tolerance with a perfect fit. Either 1" or 1¼" molds may be used with ease on the AB presses.

The new design retains the solid heater which brings the mold to top temperature faster; however, on the new model, it is not necessary to release the pressure before cooling the sample. This is accomplished by sliding the heater up the mold onto a holder pin and swinging a pair of finned cooling blocks into position, where they are held by a locking lever.

TRANSOPTIC MOUNTS provide circumambient visibility of specimen.

AB STANDARD POLISHERS—Maximum convenience and comfort in operation is attained by exclusive features such as the removable splash ring that serves as a hand rest, and the mounting of the polishing disc that is keyed to a tapered arbor on the motor by means of a stout sleeve. This reduces peripheral vibration to a minimum. The polishing disc is 8" in diameter to accommodate large specimens and gives increased peripheral speed. The disc is equipped with a new type cloth clamp for quick changing.

A complete line of equipment for the Metallurgical Laboratory . . .

SPECIMEN MOUNT PRESSES—POLISHERS—POLISHING ABRASIVES—POLISHING CLOTHS—POWER GRINDERS—BELT SURFACERS—CUT-OFF MACHINES—DILATOMETERS HAND GRINDERS—CARBON METERS—COLORIMETERS—DUST COUNTERS—EMERY PAPER GRINDERS—HARDNESS TESTERS—LABORATORY CHAIRS—MAGNIFIERS METALLOGRAPHS—MICROSCOPES—MACRO CAMERAS—PH METERS—PYROMETERS REFRACTOMETERS—SPECTOGRAPHS—STEREOSCOPES—TITRATORS

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OPTICAL INSTRUMENTS ★ METALLURGICAL APPARATUS
228 North LaSalle Street, Chicago, Illinois

Engineering Service

for

AMERICA'S

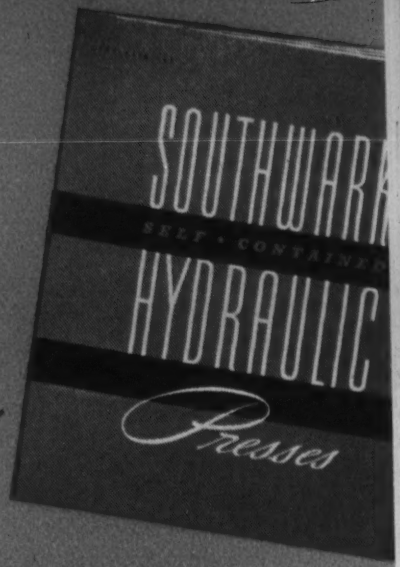
War Industries

Southwark is serving America's war industries through the manufacture of specially engineered equipment and highly developed heavy-duty standard machines designed for a host of diversified applications. With one hundred and six years of experience in the manufacture of industrial machinery, with unsurpassed shop facilities, Southwark is meeting wartime requirements for all types of hydraulic presses, physical testing machines and instruments, rolls, planers, and special machinery—large and small.

Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco, California.

BALDWIN SOUTHWARK

Division THE BALDWIN LOCOMOTIVE WORKS, *Philadelphia, Pa.*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Bulletin A-162. A discussion of wartime mater
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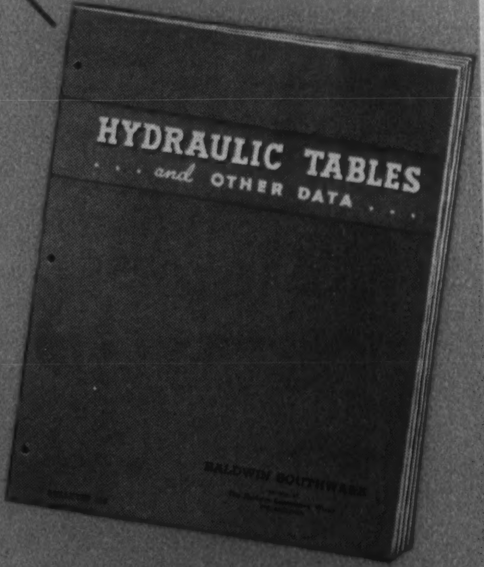
records, and the use and care of the equipme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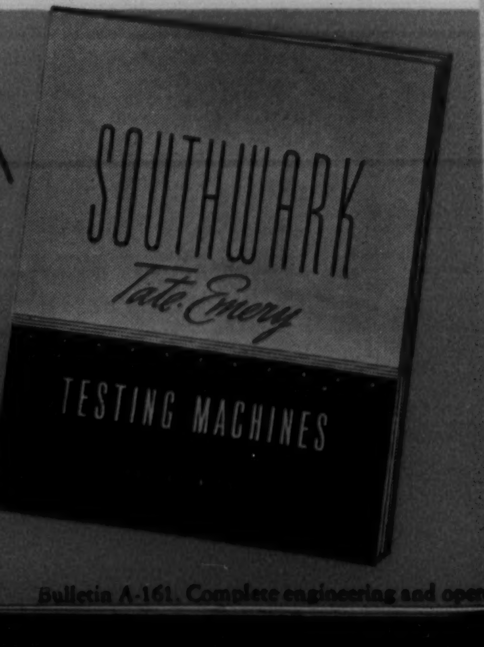
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Tate-Emery
TESTING MACHINES

Bulletin A-161. Complete engineering and oper

son. This is a matter of comparative judgment; of weighing the seriousness of varying departures from desired levels; of evaluating the possibilities and of improving known process averages; of knowing how much matériel is required and can be produced at the several process averages by available manufacturers.

If the process average is found equal to or better than the acceptable quality level, the situation is favorable to the application of quality-control techniques. A lot-by-lot acceptance inspection plan should then be inaugurated. Samples should be large enough to give a fairly prompt indication if lots begin to depart from the process average.

Inspection Practice

Acceptance of 10 to 30 consecutive lots ordinarily justifies a 60 to 85 per cent reduction in inspection, by reduction in sample size, or less frequent samples of unreduced size, or a combination of the two. Inspection results from each sample must be recorded and the trend of the process average watched continuously. Rejection of a lot ordinarily requires return to the original lot-by-lot sampling.

The quality-control inspection plan in effect on armor plate has reduced by one-half the total amount of ballistic testing necessary. The saving in plate destroyed has been substantial. The time saving for proof facilities and personnel and the reduction of the number of proof projectiles required has been important. Moreover, several manufacturers have improved the ballistic properties of their plate as a result of their better understanding of the factors by which its quality is judged.

In controlling the weight of the powder charge in small-arms ammunition, quality control has reduced the frequency of adjusting the weighing machines so that each machine is in operation an average of a half hour more each day. The product of complete rounds has evidenced improved and more uniform ballistic characteristics.

Quality control applied in the ballistic testing of armor-piercing shot has effected a substantial saving in shot, proof time and armor plate consumed.

If the process average is found poorer than the acceptable quality level, the ordnance inspector can do little but inspect large samples whenever possible and thus insure 100 per cent reinspection by the contractor of sufficient product to raise the average quality to the acceptable level. Otherwise, he can only reject the entire output until process improvements are made or accept as nonconforming such matériel necessary for essential requirements.

So far, quality-control plans have been worked out largely at headquarters or in a major arsenal or proving grounds. Plans are now under way to put responsibility in the hands of men close to inspection work. This will make it possible to tailor the plans to fit local conditions.

The Ordnance Department has undertaken a program of training conferences for inspection representatives. Little more is covered than the simple and immediate necessary principles directly applicable to these problems. The men who attend will provide a leaven of quality-control personnel throughout the country. The program involves decentralization, leaving to Ordnance headquarters only educational and general standardization work, with necessary approval of specific plans.

—G. D. Edwards, *Army Ordnance*, Vol. 23, Nov.-Dec. 1942, pp. 482-485.

Index to July-December, 1942

A complete index to the contents of the feature articles and all the departments of METALS AND ALLOYS *for the July to December 1942 issues, inclusive, is being distributed as an inserted supplement to this issue. If you or your associates need additional copies, write to the editors for them, while the supply lasts.*

—The Editors

BOTH
SPEED and ACCURACY
ARE OF THE UTMOST IMPORTANCE IN THE LABORATORY INSPECTION OF ESSENTIAL WAR METALS!

PREPARING metallurgical specimens for microscopic examination is an increasingly important function in the inspection of alloys and metals for war purposes.

The need for faster methods and more accurate results is simultaneously created by the existing critical production situation . . . *and only modern equipment which embodies the latest automatic control and timesaving principles can meet these war-borne demands!*

Equipment in the modern laboratory illustrated includes the Jarrett Submerged Specimen Cutter, the Jarrett Specimen Mounting Press and the Jarrett Metallographic Polishing Machine . . . Each unit is compact, self-contained and extremely simple to operate . . . each is specifically designed to speed specimen production, increase quality and reduce costs.

Write for the Jarrett Catalog of Modernized Equipment for the Metallurgical Laboratory

TRACY C. JARRETT
P. O. Box 3155 Catonsville, Md.

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Welding Supplants Riveting in Gun

Welding in the place of riveting increased the strength by 50 per cent and cut the cost $171.43 per unit in the manufacture of the 400-mm. Bofors anti-aircraft gun. These facts were brought out in the 2½ year, $200,000 welding study program sponsored by the *James F. Lincoln Arc Welding Foundation,* Cleveland.

Facts on the Bofors gun were presented by Dr. J. L. Miller, chief metallurgist, Gun-Mount Division, Firestone Fire & Rubber Co., Akron, Ohio, who received the $11,200 Second Grand Award. Papers were submitted from 46 of 48 states by engineers, designers, architects, maintenance men and executives. Altogether, 408 awards were made to 458 recipients.

The chassis and outrigger supports of the Bofors guns were redesigned with high-strength low-alloy steels. Though 30 per cent more weight was added, strength increased 50 per cent. The top carriage was redesigned for welding with a net saving of 17 lbs., as compared with riveted construction of the same strength.

Design involving tubes and cast steel ends joined by welding saved $68 per axle. Several smaller parts were also redesigned.

Annealers for Cartridge Cases

Flame-type mouth and taper annealing machines for steel or brass cartridge cases from 20-mm. to 3 in. and larger are announced by the *Morrison Engineering Corp.,* Cleveland. The use of steel for cartridge cases brought an insistent demand for a machine that would quickly and economically produce a uniform anneal at and near the mouth to facilitate tapering and crimping.

Morrison has brought out two general types of machines: One for cal. 50- and 20-mm. cartridge cases—the other for all larger sizes. The machine for small sizes is a straight line type; the larger is a modified dial type. They are gas-fired of the continuous conveyor type.

Cases rotate as they pass in front of the flame. Burners are of the blast line type with adjustments to provide compensation for various gases and operating conditions Loading and unloading is a continuous manual operation at one end of the machine.

When close control of temperature in the lower part of the cartridge case is necessary to prevent annealing beyond a definite point, a cold blast blower may be incorporated.

The machine could be adapted to many additional uses, such as drawing temper on file tangs, heating ends of round rods for heading or flattening operation, drawing temper on small drill shanks and annealing ends of cut lengths of copper and brass tubing.

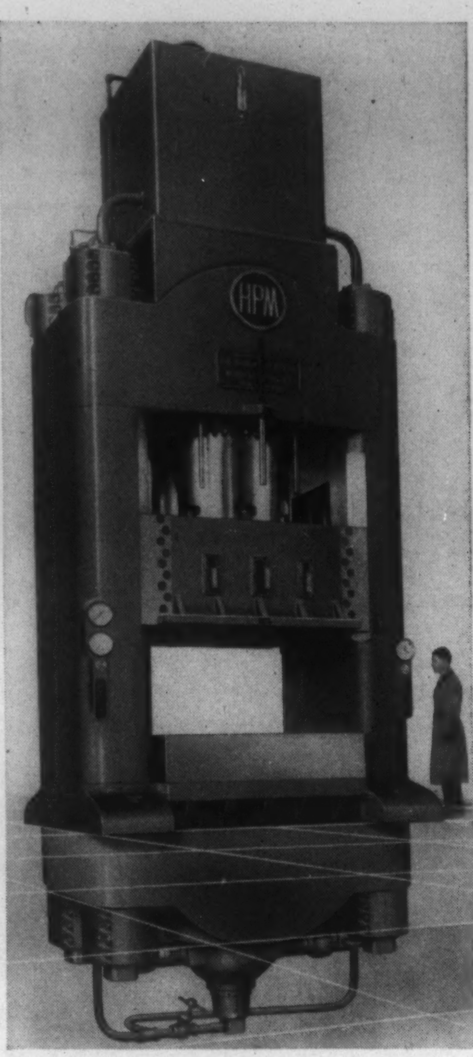
● The shortage of cylinders for chlorine, ammonia, carbon dioxide and other compressed gases becomes more acute, and all users and transportation companies must cooperate in returning the containers to producers, warns the *Mathieson Alkali Works, Inc.,* New York.

Large Deep Metal Drawing Press

• Here is another of the "world's largest" metal drawing presses, this one made by the *Hydraulic Press Manufacturing Co.*, Mount Gilead, Ohio, and with pressure capacity of 7,000,000 lbs. It embodies two hydraulic actions: a 3500-ton downward acting die platen and a 1000-ton hydraulic die cushion in the press bed.

The press can deep-draw heavy steel plate to a depth of 18 in. The die cushion press may be operated effectively on varied lengths of stroke and at full pressure capacity for any distance. Also, with die cushion idle, it can be used for single action pressing such as coining, sizing and straightening.

The compound ram system is especially beneficial when a great portion of the pressing stroke can be accomplished with medium pressure and only high pressure is required for final forming or "bottoming up." In short, the ram system is universal.



The press frame consists of a cast steel head and bed spaced by a pair of cast uprights.

HAVE YOU A JOINING PROBLEM?

Why not try

Sherman

NU-BRAZE

No. 4

The improved Silver Brazing Alloy

If your war product requires strong and leakproof joints in joining of ferrous, non-ferrous or dissimilar metals—NU-BRAZE will solve your immediate problem.

NU-BRAZE is "Better because it's Wetter" and will flow even through clearances of .001". Joints made with NU-BRAZE have high electrical conductivity and are resistant to most forms of corrosion.

SEND TODAY FOR CIRCULAR ON SHERMAN NU-BRAZE NO. 4. This circular gives you many excellent pointers on the process of brazing in general and on the use of NU-BRAZE in particular. It shows how you can speed up your production economically.

SHERMAN & CO.

Precious Metals

Refiners, Metallurgists, Manufacturers

197 Canal St. New York, N. Y.

● A flame-resistant insulating varnish for class B high-temperature insulation has been developed by *Sterling Varnish Co.*, Haysville, Pa. It is mechanically strong, dries all the way through when applied to electrical apparatus, will not support combustion and will not melt or resoften. A typical application is to protect windings of large electrical units.

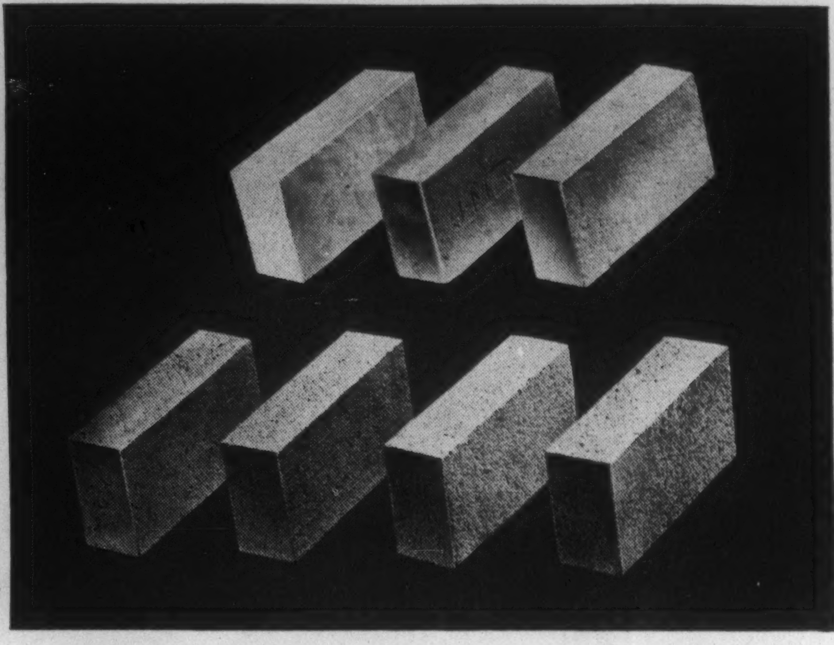
Magnification Plus Fluorescent Lighting

Inspection tools that combine magnification and shadow-free fluorescent lighting, known as Stanley "Flud-Lite" magnifiers, are produced by *Stanley Works*, New Britain, Conn. Inspectors, machinists and toolmakers in war production plants will find it useful for small parts assembly. It will find cracks and scratches and aid in inspection of machinists' tools such as reamers, gages, punches and dies.

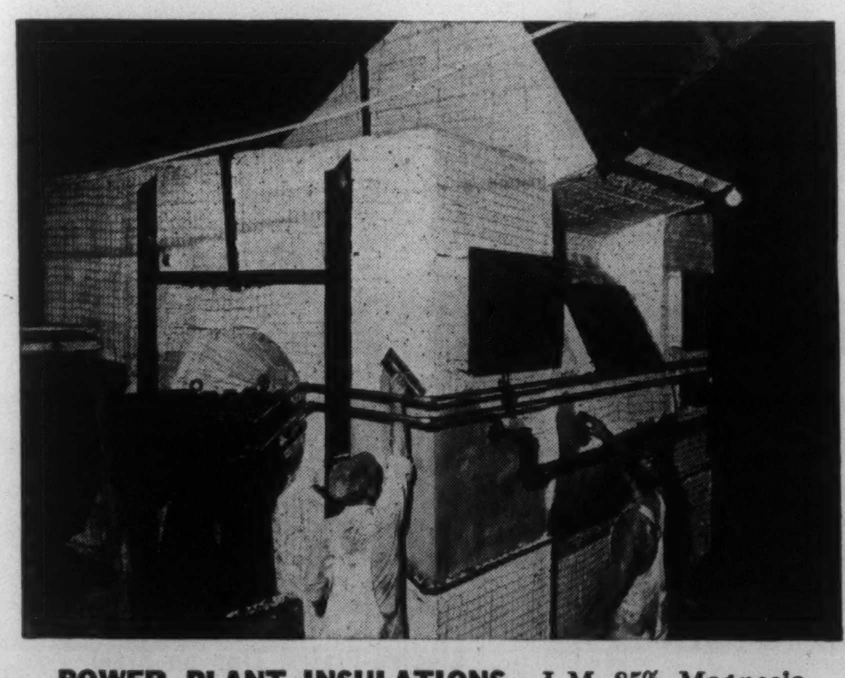
Other uses are in map making and reading, small instrument manufacture and assembly, engraving, etc. Each magnifier has a fluorescent daylight lamp, scientifically focused, which distributes natural light over an object without causing a shadow. A high quality lens, 5 in. diam., focal length of 13 in., provides full magnified vision.

Meet wartime conservation demands with
Johns-Manville Insulations

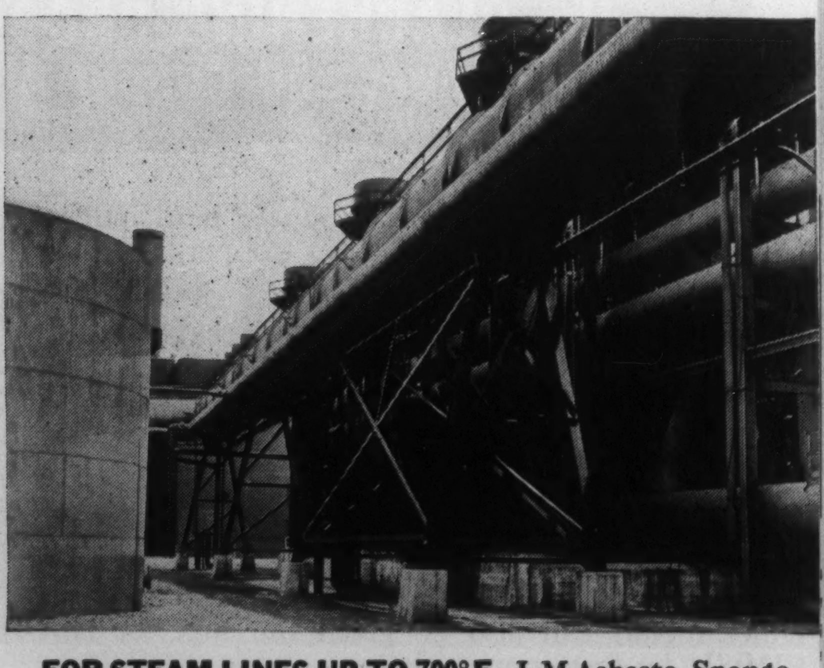
INSULATION FOR TEMPERATURES TO 1900° F. J-M Superex Blocks have long been standard for this service. High heat resistance, low thermal conductivity. Sizes 3" x 18", 6" x 36" and 12" x 36"; from 1" to 4" thick.



FURNACE INSULATION UP TO 2600° F. J-M Insulating Brick and Insulating Fire Brick are available in 7 types, with temperature limits ranging from 1600° F. to 2600° F. All provide light weight, low conductivity.



POWER PLANT INSULATIONS. J-M 85% Magnesia has been for many years the most widely used block and pipe insulation for temperatures to 600° F. and, in combination with Superex, for higher temperatures. Maintains high insulating efficiency. Standard block sizes 3" x 18", 6" x 36" and 12" x 36"; from 1" to 4" thick.



FOR STEAM LINES UP TO 700°F. J-M Asbesto-Sponge Felted Pipe Insulation is recommended where maximum efficiency, high salvage and resistance to abuse are essential. For temperatures over 700°, used in combination with Superex. It is available in 3-ft. lengths, from 1" to 3" thick, for standard pipe sizes.

JOHNS-MANVILLE
Industrial Insulations

FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

FOR DETAILS on these materials, and on the complete J-M Insulation line, write for Catalog GI-6A. Johns-Manville, 22 East 40th Street, New York, N. Y.

Gage for Measuring Lining Thickness

Portable electric gages that speedily check the thickness of surface coatings of precision-machined plane and tank parts speed production, according to H. P. Kuehni, *General Electric Co.*, Schenectady.

Steel bearings going into plane and tank engines are lined with lead-bronze, copper, silver or heavy babbitt while other steel parts are often plated with chrome, nickel or cadmium. The thickness of lining or plating must be accurate to a thousandth of an inch, and can be measured by the electric gage.

The main part is a 7-lb. portable indicating unit with a dial marked off in thousandths of an inch. A small cylindrical gage head containing an electro-magnet is connected to the indicating unit by a light weight cable. The instrument is plugged into an ordinary a.c. outlet.

When placed against a surface, the gage head can measure the thickness of any non-magnetic layer up to 0.3 in. thick and backed by steel. The head sets up electric currents in the instrument that vary in intensity with different layer thicknesses. By measuring the currents, therefore, the instrument can indicate the exact thickness on a dial large enough to be read at a glance.

This gage was developed originally to measure the thickness of paints. It can also measure the thickness of sheets of glass or mica, provided they are placed on steel tables or otherwise backed by steel at the point of measurement. A different type of gage is used for measuring the thickness of non-magnetic metal sheets and plates. It is used to check the wall thickness of magnesium and aluminum alloy castings rolling off assembly lines, no steel backing being necessary.

Until a few years ago thicknesses of lining or plating were checked by complex processes that involved selecting a few at random as they came off the assembly line, cutting them open, and placing them under a microscope. Or, wall thickness was measured before and after the lining was removed, the difference representing the thickness. The portable electric gage measures without marring any of the parts.

• For removing rust, scale and burn marks from machine tools, Corrosol 26 has been put out by the *International Rustproof Corp.*, Cleveland, Ohio. Ordinary pickling leaves the metal in a state to invite corrosion, but Corrosol leaves it in a passive condition.

Electro-Plated Zinc on Steel

An electro-plated zinc on steel, called a satisfactory substitute for pure nickel, tin, chromium, aluminum or stainless steel, has been brought out by *American Nickeloid Co.*, Peru, Ill.

The zinc makes the sheet highly resistant to corrosion and rust. A galvanic action takes place between the zinc coating and the base metal, which gives additional corrosion-resistance.

It can be bent, stamped, formed, drawn, soldered and spot welded. It does not crack or flake. It comes in sheets, in sizes up to 36 x 96 in. and in a full range of gages and tempers, in polished, unpolished and satin finishes.

It's different!

EBONOL "C"
the BLACKENING PROCESS
for Copper and Copper Alloys

EBONOL "C" is unique! It produces hard, adherent, black inorganic finishes (either dull or glossy) on Copper, Brass or Bronze.

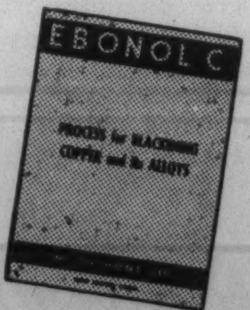
It is not a sulphide type black but a cupric oxide finish, with all the physical and chemical advantages of cupric oxide. The coatings are far superior to black nickel, and require no critical materials. The finishes are easy to apply to either large single objects or small parts in bulk. Simple immersion for from 2 to 15 minutes at 200°F is all that is necessary. Control is also simple.

EBONOL "C" finishes are widely used and approved for the blackening of war goods such as optical items, measuring and precision instruments, grommets, wire products and airplane accessories.

Other metals can also be given the superior EBONOL "C" BLACK FINISH by first copper plating.

Other EBONOL Blackening Processes

EBONOL "A" for Aluminum and its alloys
EBONOL "S" for Iron and Steel
EBONOL "Z" for Zinc plate and Zinc alloys



Write for Folder "C" or send samples for processing.

THE **Enthone** CO.
NEW HAVEN, CONN.

Chicago Representative:
GEORGE A. STUTZ MFG. CO.
1641 Carroll Ave., Chicago

Detroit Representative:
FREDERIC B. STEVENS, Inc.
Larned & 3rd Sts., Detroit

SAVE VITAL TIME
12
11
1
3

... BUILD DURABLE CORROSION-RESISTANT EQUIPMENT with PENCHLOR ACID-PROOF CEMENT
REG. U. S. PAT. OFF.
Quick-setting • Self-hardening

Wartime needs demand time-saving wherever possible in acid-proof construction. Wartime pressure for the utmost in production means that corrosion-resistant construction *must* stand up. Penchlor Acid-Proof Cement meets both these requirements with a record of proved performance.

With Penchlor Acid-Proof Cement you can get brick-lined equipment into service without delay because this tough, long-lasting sodium silicate cement offers these advantages: Quick-setting and self-hardening—easily handled—no heating required—no drying delays—no acid treatment.

Continuous production is possible because Penchlor Acid-Proof Cement has proved itself in years of uninterrupted service. Great strength and minimum porosity reduce repairs to a minimum. The mortar set is permanent. There is less shrinkage with Penchlor Acid-Proof Cement. It is steam and water resistant. It adheres well to a wide variety of construction materials.

Industries Using Penchlor Acid-Proof Cement

- Acids
- Alum
- Bleaching and Dyeing
- Chemical
- Coke and Gas
- Distilling
- Electrochemical
- Electroplating
- Explosive
- Fertilizer
- Glass
- Lacquer
- Leather
- Metal Pickling
- Oil
- Paper and Parchment
- Pulp
- Rayon
- Rubber
- Smelting
- Spark Plugs
- Steel
- Tanning
- Textile

PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals
1000 WIDENER BUILDING • PHILADELPHIA
New York • Chicago • St. Louis • Pittsburgh • Wyandotte • Tacoma

Where conditions require a cement of unusual strength and high resistance to abrasion, consider these Penn Salt *resin* cements: *Asplit**, for conditions always acid . . . *Causplit**, for alternate acid and alkaline conditions. These are easy to handle and will withstand a wide range of corrosive conditions up to 350 degrees F.

★ ★ ★

At your service, without obligation, is the long experience of our engineers in handling acids and alkalis in our own plant. Write fully. Or if you prefer, use the coupon.

*REG. U. S. PAT. OFF.

PENNSYLVANIA SALT MANUFACTURING COMPANY
Dept. MA, 1000 Widener Bldg., Philadelphia, Pa.

I would like to have a free copy of your new booklet No. 6 on Penchlor Acid-Proof Cement.

NAME____________________
COMPANY____________________
ADDRESS____________________

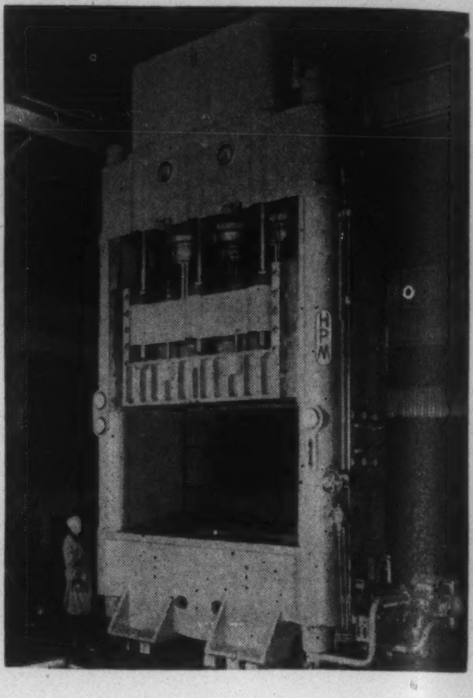
Deep-Drawing Press for Sheets

Two self-contained deep-drawing presses for sheet metal, depicted here, were recently installed in the Willow Run plant of the *Ford Motor Co.* They are the H-P-M Fastraverse presses made by the *Hydraulic Press Mfg. Co.,* Mt. Gilead, Ohio. They are equipped with blankholder and die cushion for drawing large, deep-metal airplane parts.

The press is of universal design and can be used to deep-draw aluminum alloy, steel and other sheet metals. It will accommodate all standard types of deep-drawing dies, or can be employed for single action press work such as coining, sizing and straightening.

Blankholder pressure is variable at six points on the periphery of the blankholder ring. The pressure resistance of each of the six blankholder rams can be adjusted individually and independently. This is an invaluable feature when drawing parts of irregular contours, where the blank must be held more securely at certain points and be permitted to slip at other points.

Another remarkable feature is that only one hydraulic pump (pressure generator) is required. Oil trapped in the blankholder and die cushion cylinders is intensified by the downward acting movement of the upper punch carrying slide. These intensified pressures produce the resistance forces necessary for holding the blank and cushioning the draw.



Electric pushbutton controls are provided so that the press may be operated manual, semi-automatic or full automatic.

• Meehanite was specified as a suitable metal for cargo vessel propellers by the Maritime Commission recently. It has increasing use in propellers, blades and hubs, being an effective substitute for tin and copper, states the manufacturer, *Meehanite Research Institute,* Pittsburgh. Meehanite in propellers provides high tensile strength, adequate resistance to cavitation and erosion and good resistance to shock or impact.

Welder With 20 to 625 Amperes Range

A heavy-duty manually-operated welder, with range of 20 to 625 amps., is introduced by the *Glenn-Roberts Co.,* Oakland, Cal. and Indianapolis. According to the maker, this is the first manual welder to offer such a wide range of heats in a single machine.

It handles a great variety of jobs from light sheet metal to heavy production work. Low range provides heat from 20 to 200 amps.; high range from 200 to 625 amps. Stepless heat control is maintained throughout the entire output range.

The operator's safety has been a prime consideration in the design of the new model 45.

VAPOR BLAST

***abrasive* CLEANING . .**

Speeds Up Wartime Metal Work!

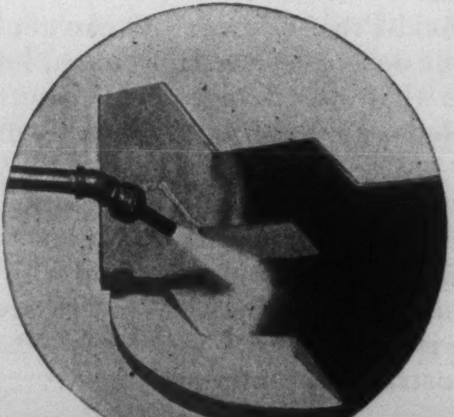
That's what Industrial users claim of the new VAPOR BLAST SYSTEM of Abrasive Cleaning!
Using SAND for abrasive cleaning — "WATER to eliminate Dust—CHEMICAL (Metrolux) to prevent RUST," it offers THREE-WAY efficiency that quickly removes dirt, scale, welding flux, oxide, spatter-off compound and other residues from metal parts of all kinds.

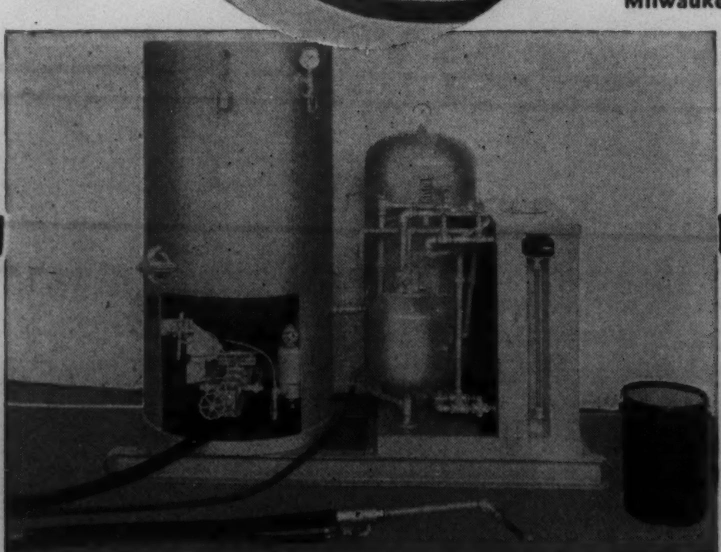
Provides a smooth, rust-resisting surface capable of modern scientific methods of inspection—ready for any type of finish.
VAPOR BLAST Abrasive Cleaning is already doing a "Wartime Speed-up" job in famous Aircraft Plants, Shipyards, Foundries, Machine Tool and Structural Steel Plants—wherever SPEED is essential in cleaning, degreasing, descaling metal and metal parts.

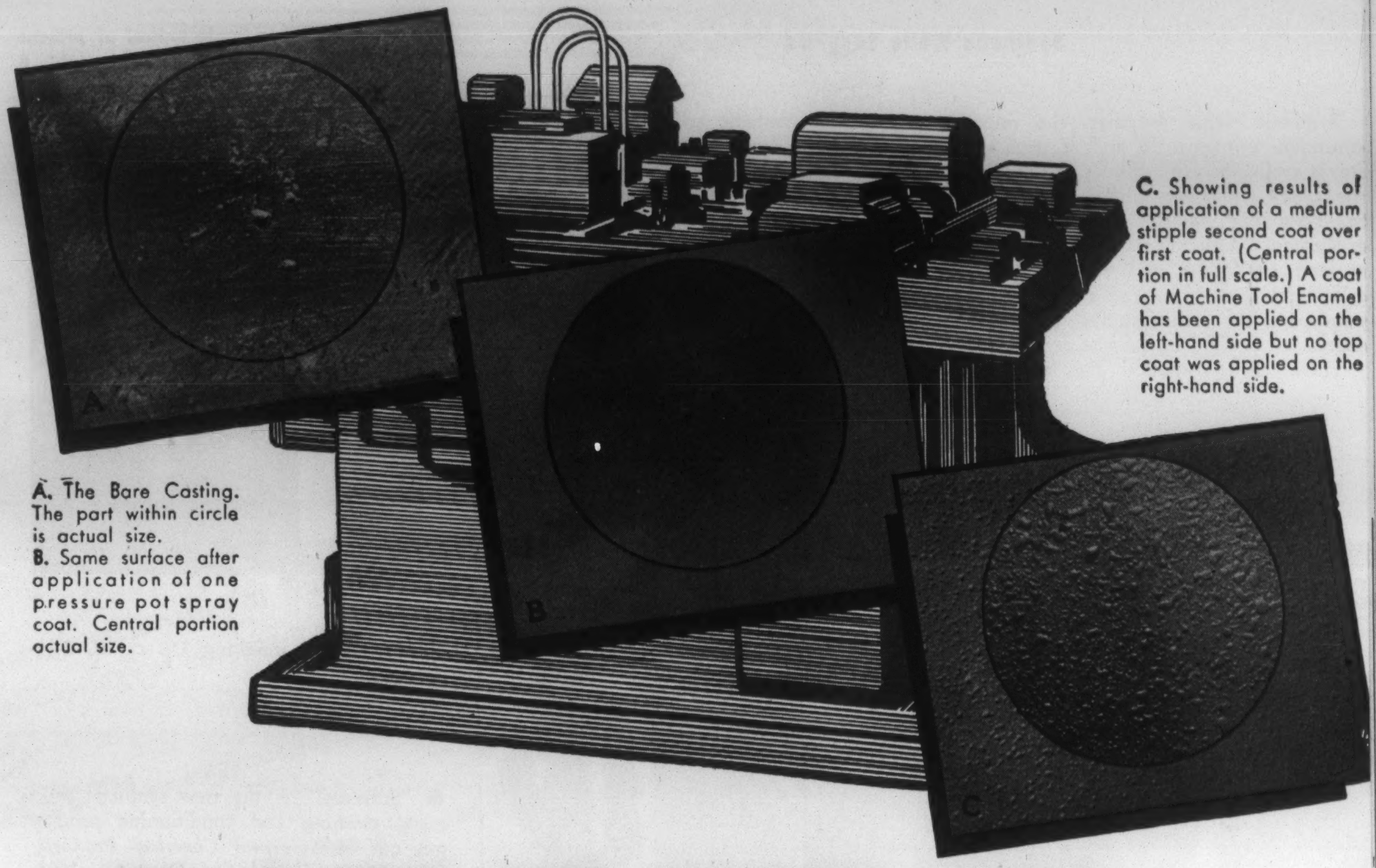
Call in a VAPOR BLAST Engineer for specialized service to help make YOUR cleaning operations more effective, more efficient and economical.

VAPOR BLAST
MFG. COMPANY
333 South 16th St.
Milwaukee, Wisc.

Standard VAPOR BLAST Unit. Also available in specially engineered units for production applications.







A. The Bare Casting. The part within circle is actual size.
B. Same surface after application of one pressure pot spray coat. Central portion actual size.

C. Showing results of application of a medium stipple second coat over first coat. (Central portion in full scale.) A coat of Machine Tool Enamel has been applied on the left-hand side but no top coat was applied on the right-hand side.

A NEW MACHINE TOOL FINISHING SYSTEM FOR PRESENT HOUR NEEDS

Here's a NEW machine tool finishing system which is entirely consistent with WPB Limitation Order L-108. Designers, finishers and customers are enthusiastically endorsing it wherever it is used.

It's a three coat system which produces a stipple effect, minimizing those rough spots found in every casting by blending them with the rough finish.

It can also be used for a smooth finish where desired since it gives a maximum of filling and smoothness to castings consistent with a complete spray job.

Here are the high lights of the NEW EGYPTIAN Machine Tool Finishing System.

1 FAST, AIR DRYING Lacquer materials.
2 No Primer required.
3 Oil and alkali resistant.
4 Applied by spray or brush.
5 Finish levels or rounds out as it dries.
6 Gives stipple effect in two coats. A coat of EGYPTIAN Machine Tool Enamel completes the job.
7 Any make of Stipple equipment may be used. Spray equipment manufacturers can furnish suitable accessories to go with equipment for proper application.

Ask us for detailed information about the new EGYPTIAN Machine Tool Finishing System . . . or better still let us ship you a trial order at drum prices.

UNITED STATES
GOVERNMENT
SPECIFICATION
FINISHES
THE EGYPTIAN LACQUER MANUFACTURING COMPANY

Send for this new Gov't "Spec" Book. Contains information concerning specifications for the more important finishes used on equipment for all branches of the Service. Just ask for "Spec" Book MA.

EGYPTIAN FINISHES

THE EGYPTIAN LACQUER MANUFACTURING CO.
ROCKEFELLER CENTER—NEW YORK, N. Y.

EGYPTIAN
Superior **FINISHES**

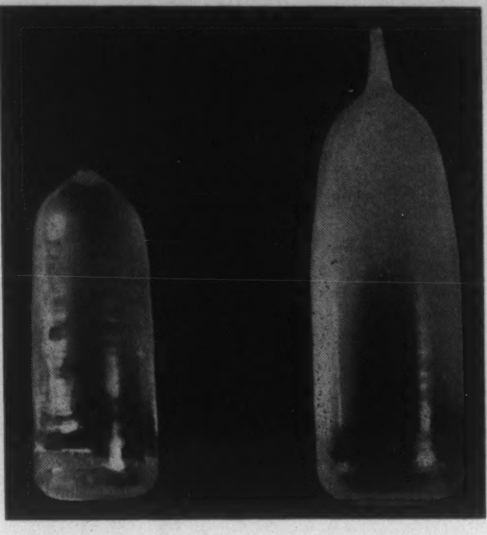
Synthetic White Sapphire

Synthetic white sapphire, the mineral corundum unpigmented and of gem quality, is available in the form of boules from the *Linde Air Products Co.,* 60 E. 42nd St., New York, a unit of Union Carbide & Carbon Corp. The boules each weigh at least 150 carats, and are of a regular cylindrical shape, enabling gem cutters to standardize on cutting and sawing procedures.

These have surpassed the quality of European synthetic gems in some respects. Hardness is exceeded only by the diamond. They have a melting point of over 3,700 deg. F.

Besides the orthodox uses as jewel bearings in chronometers, etc., they are suitable as orifices for flow meters and oil-burning equipment and for cutting tool tips for high-speed finishing operations on certain non-ferrous metals.

In the accompanying photograph, on the left is a 200-carat boule typical of present commercial production; on the right a "1943 model," weighing 350 carats, 2-¾-in. long.

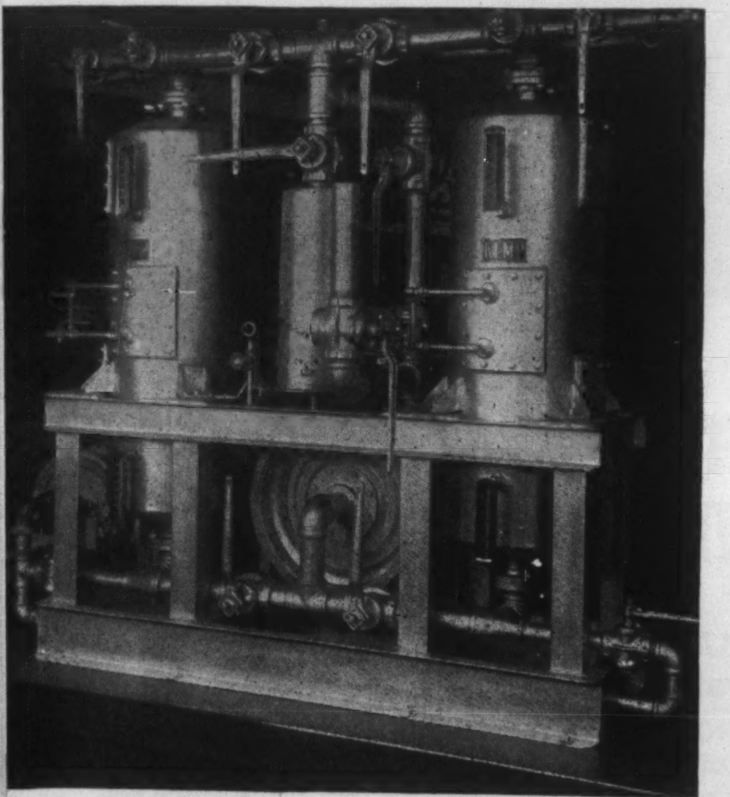


● "Solventol" is the new synthetic fluid metal cleaning and conditioning product put out by *Solventol Chemical Products, Inc.,* 15841 Second St., Detroit. It is claimed that the fluid prevents rust and corrosion, removes smut, abrasives and lead, increases the salt spray test in paint, protects against finger marks, cleans all alloy parts safely, eliminates oil slushing, cleans before and after Magnaflux, reduces washing to one stage, and streamlines washers and layouts.

World's Fair Planer Still Working

A 12-foot planer that was exhibited at the World's Columbian Exposition at Chicago in 1893 has been revitalized at one of *General Electric's* New England plants, and today is working on propulsion equipment for combat and cargo ships. It cost $25,000 to rebuild the machine, but it is equal in performance to that of a new one costing $125,000.

Previously it was a tedious job to move the tool head or the cross bar. Now these and similar operations are made easier and faster by electric push-button control.



for DRY

ANNEALING ATMOSPHERES

KEMP SILICA GEL DEHYDRATORS guarantee the *exact* degree of dryness you need in *your* annealing atmospheres.

Designed by gas equipment engineers; and proven by an impressive record of dependable and economical operation in plants demanding constant and exact drying of annealing atmospheres.

Write **The C. M. Kemp Mfg. Company, 405 East Oliver Street, Baltimore, Maryland—ask for Dryer Bulletin.**

STANDARD UNITS BUILT TO GIVE:
Capacities: 10 to 100,000 c.f.m.
Pressures: Atmospheric to 2500 lbs. per square inch
Adsorbent: Silica Gel, high capacity, long life
Activation: By gas, electricity, or steam, as desired
Types: Single or twin towers for intermittent or continuous operation

ARMY E NAVY

The Army-Navy E flag, awarded "for high achievement in the production of materials of war", proudly flies at The C. M. Kemp Mfg. Co.

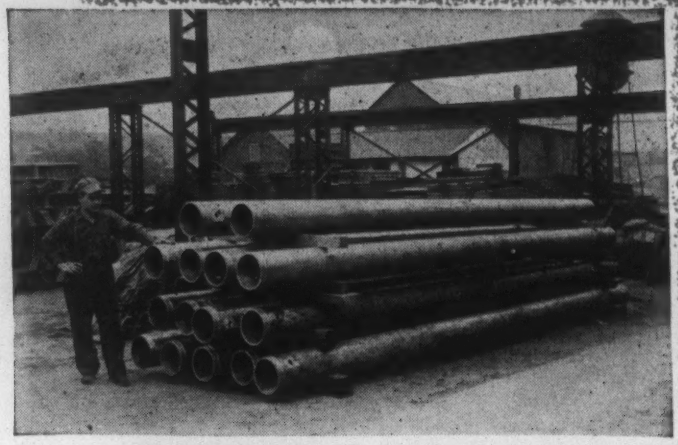
EMP of BALTIMORE

DURASPUN CENTRIFUGAL CASTINGS

REG. U. S. PAT. OFF.

CENTRIFUGAL CASTINGS

The Superior Castings for Tubular Products

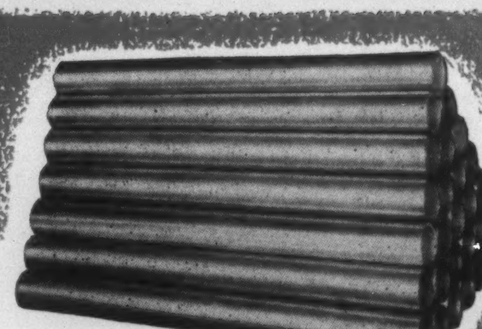


Here are characteristics of Duraspun Centrifugal Castings of chrome-iron or chrome-nickel . . .

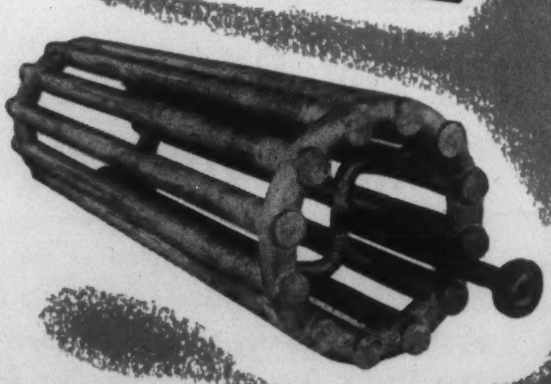
STRENGTH . . . approaching that of forged steel.

STRUCTURE . . . very fine grain and free of gas pockets and blowholes.

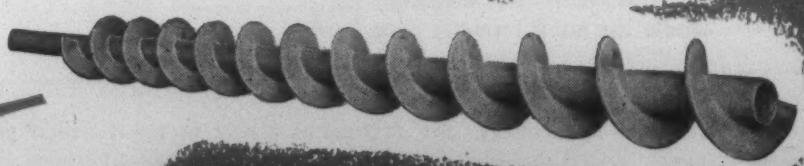
SHAPE . . . true concentricity of diameters; uniform wall thickness; exceptional straightness. Odd external shapes are practical; the only requirement being the straight hole through the center.



For many tubular installations, the superior qualities of Duraspun Centrifugal Castings are to be preferred to those of static castings, drawn or welded tubing. The centrifugally cast tubing will be stronger and more durable.



To get more fully acquainted with Duraloy's service on centrifugal tubular castings, why not send for our Bulletin 4227-C?



THE DURALOY COMPANY

Office and Plant: Scottdale, Pa.
Eastern Office: 12 East 41st St., New York, N. Y.

Detroit:
The Duraloy Co. of Detroit

Scranton, Pa.:
Coffin & Smith

Metal Goods Corp.: St. Louis—Houston—Dallas—Tulsa—New Orleans

1-DU-2

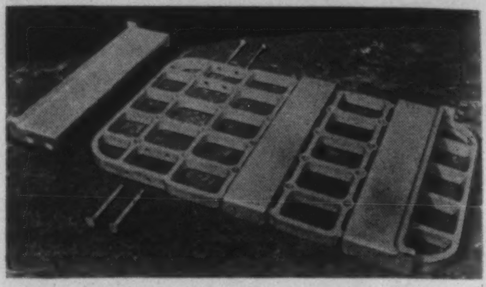
Warped Trays Can Be Reversed

New trays for heat-treating and carburizing differ from the ordinary type in that the rails are detachable and the trays can be reversed when warpage occurs. They can be straightened merely by using them under load after reversing. Pins that are easily torch cut, without damaging the trays, hold the rails in place.

Severe thermal strains that lead to cracking, inequality in the heating and cooling cycles and other faults of conventional carrier tray design are eliminated in the new Amsco-Johnson tray, according to the *American Manganese Steel Div., American Brake Shoe & Foundry Co.*

Since they are made separately, the rails and trays expand and contract independently. Objectional foundry defects, sometimes the source of premature failure in a one-piece tray, resulting from weakening shrinkage areas at the junction of unequal metal sections under the rails, are avoided by the sectional construction.

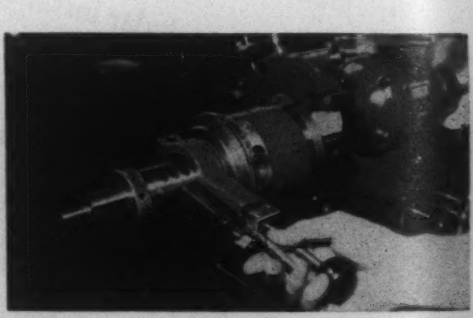
Each of the trays illustrated here consists of a grid, two side runners, or rails, one center runner and twelve pins for assembly, weighing 65 lbs. a tray. They are used in a continuous-type furnace for conveying small tank and tractor parts such as gears, clutches and steering knuckles which, during the cycle, are heated to about 1650 deg. F. and then quenched with oil. The tray is not quenched.



● An electric etcher for marking trade names, defense plant order numbers, etc. on iron, steel and alloys is announced by the *Ideal Commutator Dresser Co.* 1928 Park Ave., Sycamore, Ill. "Hi-Lo" taps and a seven-point switch give 14 etching heats between 115 to 1300 watts. The tool has special heat radiating fins and an alloy tip point.

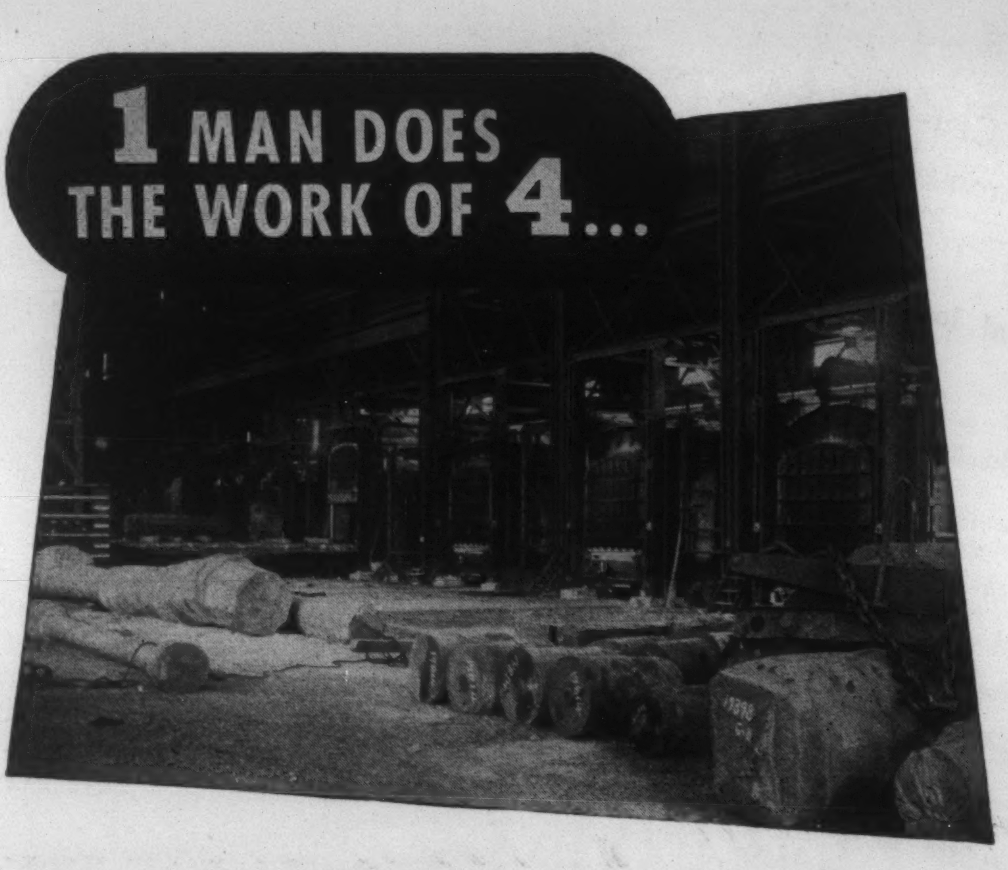
Improved Tap Reconditioner

An increase in capacity of its tap reconditioner is announced by *Detroit Tap & Tool Co.,* 8432 Butler St., Detroit. It handles all sizes and types of taps up to 1¼ in. diam., including long shank tapper taps, the latter possible because of a "through" hole in the top chamfering head.



Spiral pointing and polishing of spiral points can also be done. In the photo, a long shank tap is being chamfered on the improved reconditioner.

● Metso Anhydrous is the latest in the line of cleaners of the *Philadelphia Quartz Co.,* 121 S. Third St., Philadelphia. It is a technical grade of anhydrous sodium metasilicate, without water of crystallization. It is sized to reduce dustiness and permit ready solubility, and has compatibility with soap, wetting agents and other alkalis.



WITH THE RYAN ELECTRIC DOOR LIFT AND AUTOMATIC CONTROL

The above illustration is typical of the war production jobs which Ryan Electric Door Lifts and Automatic Controls are doing. In this plant — as in scores of other vital heat-treating industries — the Ryan Electric Door Lifts and Handling Equipment enable 1 man to handle the work formerly done by 4.

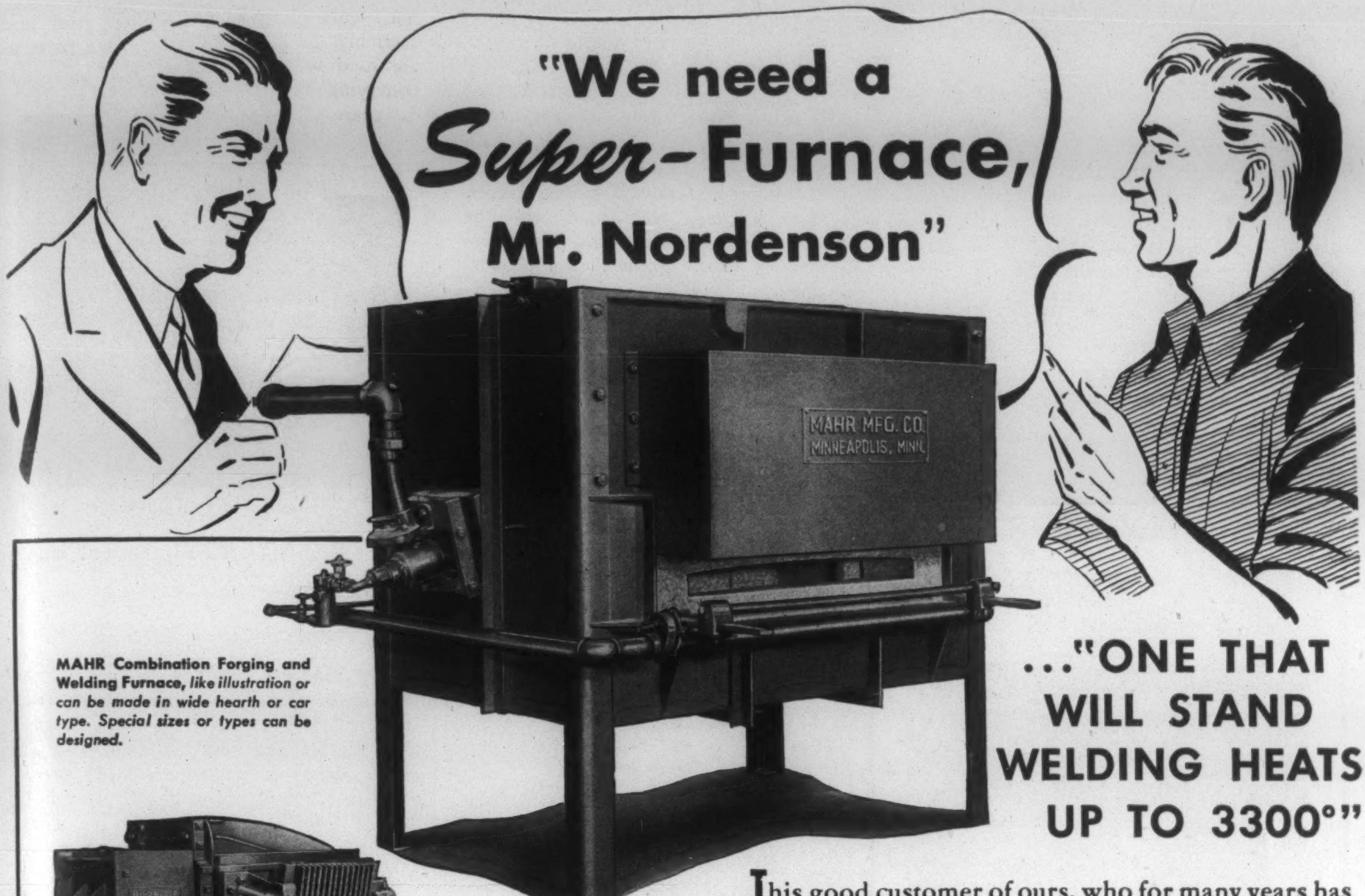
Charging and discharging operations are performed with precise timing, minimum heat losses, and maximum quality in the finished product.

Ryan Lifts and Controls are installed in a few hours on either new or old installations. A new complete technical Bulletin forwarded on request.

Conserve time . . . . CONSULT RYAN!

ENGINEERED FJR EQUIPMENT

FRED J. RYAN COMPANY
LOCATED IN A PHILA. SUBURB . . . WYNCOTE, PA.


"We need a Super-Furnace, Mr. Nordenson"
MAHR MFG. CO. MINNEAPOLIS, MINN.

MAHR Combination Forging and Welding Furnace, *like illustration or can be made in wide hearth or car type. Special sizes or types can be designed.*

..."ONE THAT WILL STAND WELDING HEATS UP TO 3300°"

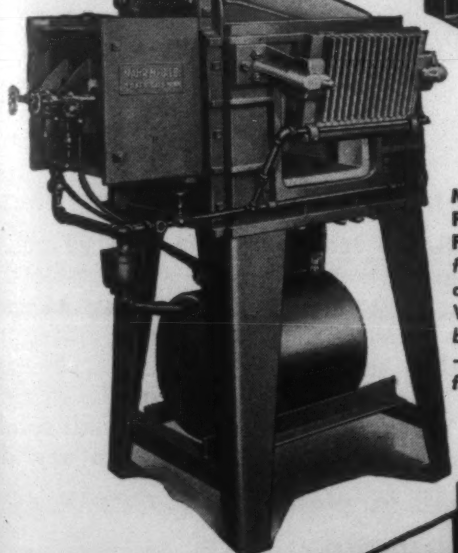
This good customer of ours, who for many years has depended on MAHR Performance-ability, had been trying to make a MAHR Forging Furnace do double duty at the extreme heats he required for welding. So he put his problem up to Mr. A. J. Nordenson, our Executive Engineer, who watched the welding operations in his plant and soon saw what was needed. "We'll build you a 'Super' Furnace, to stand the welding heats you use and also handle forging work," he told the customer.

"The difficult we do at once—the impossible takes a little longer"—might well be the battle-cry of MAHR Engineers. If you have a heat treating "nut" that's hard to crack—consult MAHR for any size or type of heat processing equipment, from bench type to the largest car or continuous type. Wire, write or phone today.

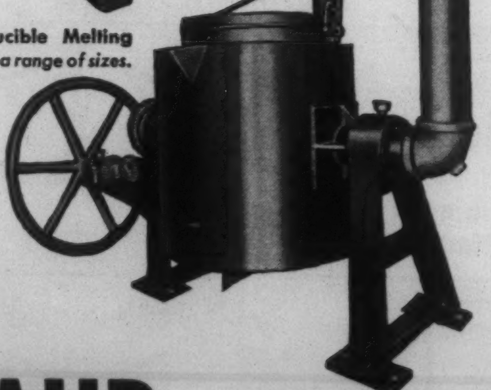
Sales Offices in Principal Cities

MAHR MANUFACTURING CO.

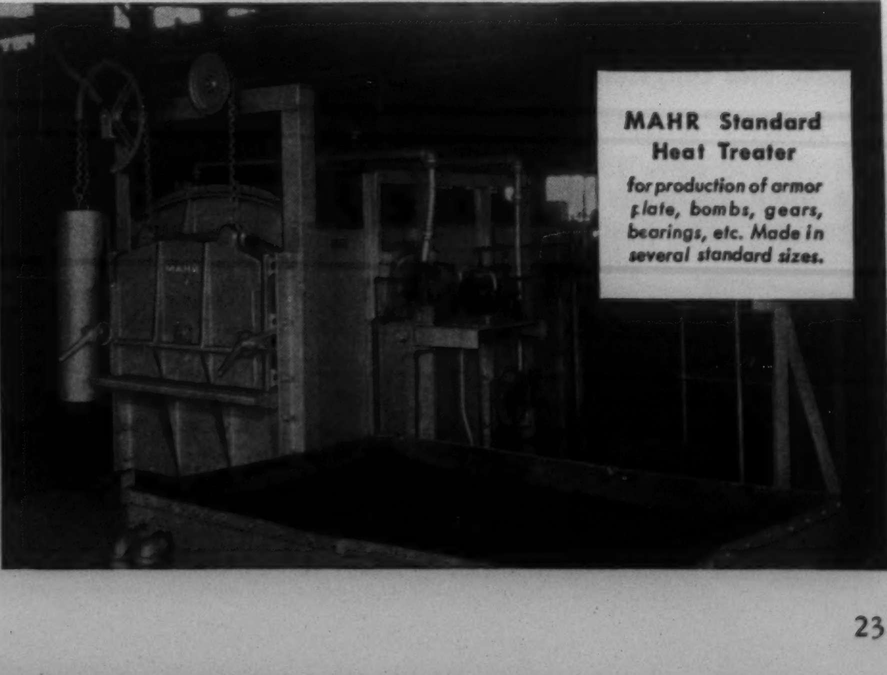
DIVISION OF DIAMOND IRON WORKS, INC.
1701 North Second Street • Minneapolis, Minnesota



MAHR No. 35 Portable Forging Furnace, *for small forging operations and rivet heating. Vacuum fuel feed by compressed air —safe—very efficient.*



MAHR Crucible Melting Po, *made in a range of sizes.*



MAHR Standard Heat Treater
for production of armor plate, bombs, gears, bearings, etc. Made in several standard sizes.

MAHR FURNACES

FOR EVERY HEAT TREATING NEED

Annealing
Carburizing
Baking
Hardening
Forging
Drawing
Stress Relief

Furnace Types:
Car Bottom
Pit
Pusher
Roller Hearth
Continuous
Pot
Rotary

Other MAHR Equipment:
Rivet Forges
Torches
Burners
Blowers
Valves
Smithing Forges

Direct-fired, recirculating or radiant tube types for both HIGH and LOW temperature ranges

Aircraft Cowls Made by Spinning

Metal spinning, which is usually identified with the manufacture of art goods and dining room dishes, has been adapted to war work. Illustrated herewith is a large aircraft engine cowl. The original plan called for stamping this part out in sections, then welding together. This would have entailed making stamping dies, a long process, and the finished products would have meant exposed rivets, causing air resistance.

Milwaukee Metal Spinning Co., Milwaukee, butt-welded two narrow sheets together, since no aluminum sheets were available in large enough pieces. Necessary wood patterns were made and the cowl was spun successfully in a few hours. The samples were approved and production started immediately, enabling delivery weeks ahead of schedule.

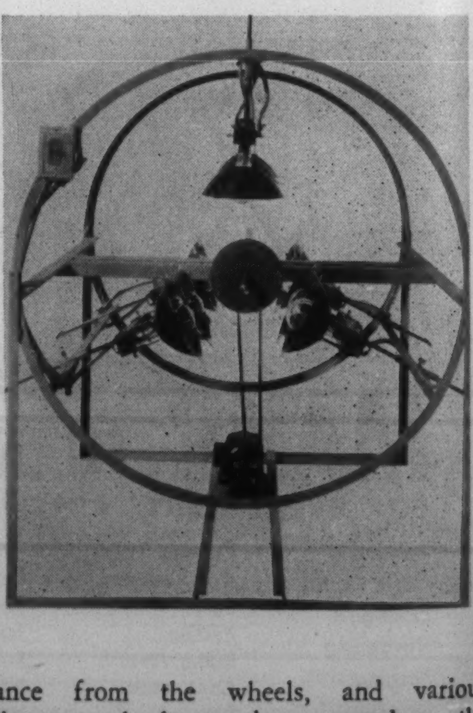
Today, the metal spinner is capable of working in all metals, even the harder alloys such as Monel, stainless steel and even magnesium, holding intricate parts to close tolerances previously deemed impossible.

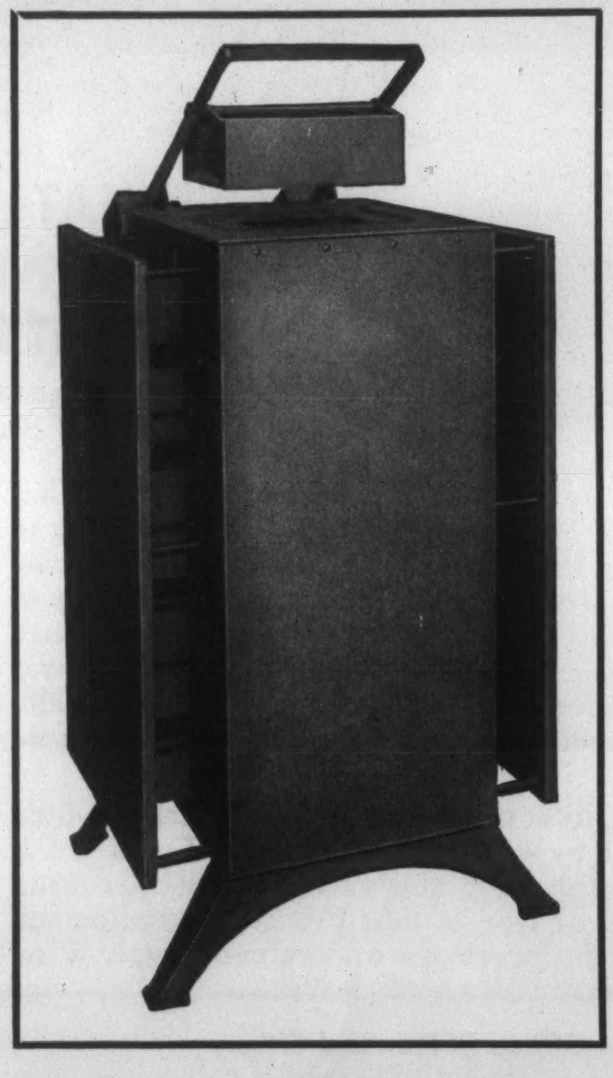
● An improved free-flowing flux for gas welding of aluminum and its alloys, "Flo-Ez-Flux," is being made by *Park Stewart,* 1045 Carbis St., Worthington, Pa. The maker claims it will not solidify or deteriorate. It will gas weld either wrought, cast or high tensile aluminum or alloys, and is used in the aviation industry. It is packaged in glass bottles from 1/4 lb. to 25 lbs.

Infra-Red Oven for Polishing Wheels

A new infra-red drying oven for polishing and buffing wheels — a portable unit — can cut drying time from 24 hrs., the usual period, to 30 min., states the maker, the *Park Chemical Co.,* Military & Vancouver Aves., Detroit.

Wheels pass three lamps in each revolution. Lamps are adjustable to any distance from the wheels, and various diameter wheels can be mounted on the drying shaft by special bushings. The unit is 54 in. square by 66 in. high; the working height of the loading shaft is 42 in. from the floor.





NO

Lost

TIME

Between Furnace and Production

Putting tools to work immediately after drawing, by eliminating refinishing and straightening operations, is a real saving of skilled labor and machine time. The savings are especially important when large or long drills and reamers of high speed molybdenum, cobalt, and tungsten steels are being hardened.

A Sentry Vertical Muffle Furnace, using Sentry Diamond Blocks, will give you these savings. Tools are hung vertically eliminating tendency to warp when hot. The positively controlled neutral atmosphere results in maximum hardening — no scale — no reduction in size — no decarburization.

Sentry DIAMOND Block

Sentry Diamond Blocks automatically maintain a neutral atmosphere that does not depend on analysis or manipulation. Blocks available in sizes to meet your requirements

Sentry "Always on Duty"

The Sentry Company
FOXBORO, MASS., U. S. A.

TEETH THAT BITE THE EARTH
LAST 5 TIMES LONGER
WITH P&H HARCOTE

Here's an example of the way P&H hard surfacing electrodes can help you. Built up with P&H "Harcote" and ground with a portable grinder, these ditcher bucket teeth last five times longer than before. The user claims an extra five miles of trench between sharpenings.

In all kinds of construction, mining, agricultural, and transportation equipment, P&H Alloy Electrodes are serving the war effort—keeping machinery on the job at peak efficiency.

If you have a problem in maintenance or repair of equipment solve it with P&H Alloy Electrodes. These include such indispensable electrodes as P&H "Harcote" for hard surfacing to give longer life to many parts. Other P&H Alloy Electrodes are available for resistance to wear, abrasion, impact; for welding stainless, 4-6% chrome steel, etc.

P&H Alloy ELECTRODES

Your nearest P&H welding representative will gladly advise you. See him, or write us for information. Ask for data sheets on how to select and use P&H Alloy Electrodes.

ARMY E NAVY

A new star has been added to P&H's award for continued excellence in war production.

General Offices: 4550 West National Avenue, Milwaukee, Wisconsin

HARNISCHFEGER CORPORATION

WELDING ELECTRODES • MOTORS • HOISTS P&H ELECTRIC CRANES • ARC WELDERS • EXCAVATORS

Canadian Distribution: The Canadian Fairbanks-Morse Co., Ltd.

OXYGEN
FREE
HIGH
CONDUCTIVITY

OFHC
REG. U.S. PAT. OFF.

A SUPERIOR COPPER
FOR ALL PURPOSES

OFHC Copper conforms to the A.S.T.M. Specifications for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact. OFHC Copper withstands more working in hard condition when tensile strength is greatest, making it especially suited for products subjected to severe fabricating or service conditions.

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER

BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

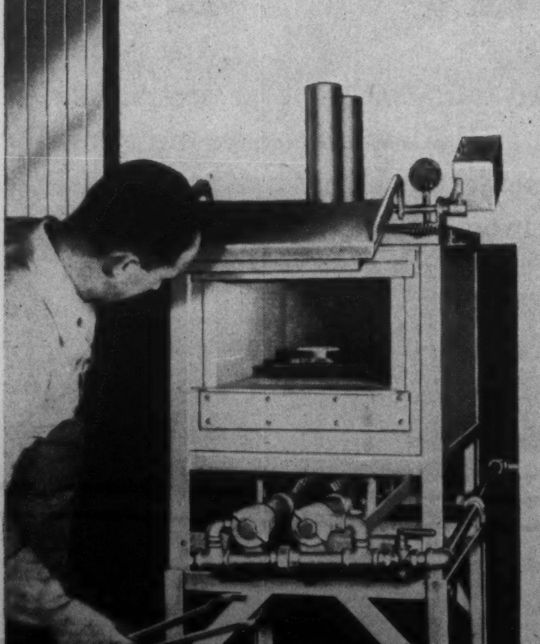
There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

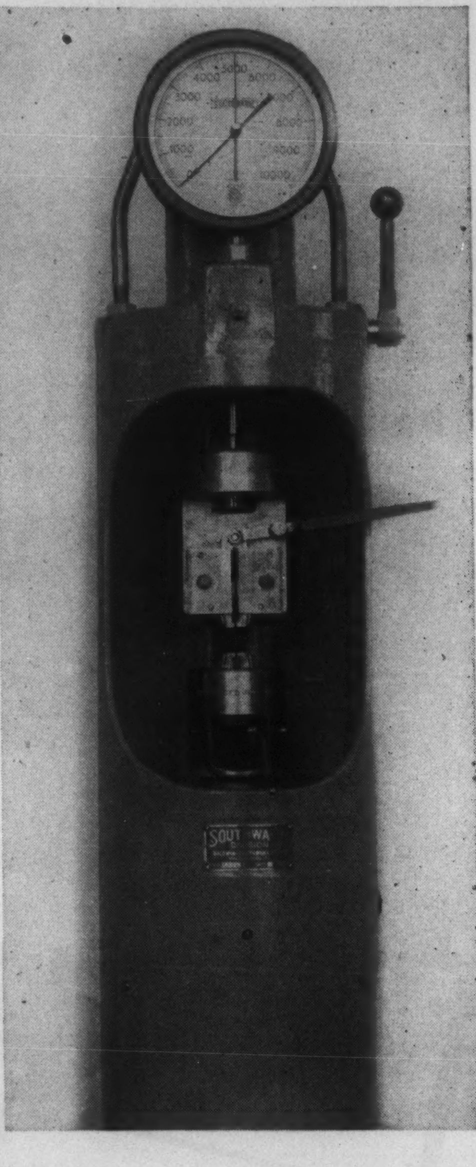
Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.
113 Astor St., Newark, N. J.



Spot Weld Testing Machine

A spot weld testing machine, to check the strength of spot-welded samples in the factory, has been developed by the *Baldwin Southwark Div., Baldwin Locomotive Works,* Philadelphia. It is for production line testing of light metal fabrication and is equipped with specially designed, self-aligning, lever-operated, open-face grips with renewable hard file faces.



Grips accommodate offsets in welded specimens from the smallest gage to ¼ in. thick. No backing plates or liners are needed. Top and bottom handling levers are set at right angles. An 18 in. steel base and low center of gravity facilitate hand moving of the machine. It has an overall height of 70 in. and weight of 800 lbs.

● A load calculator, the Motorule, which simplifies computing motor horsepower needed for metal cutting on various machine tools, is offered free by the *General Electric Co.,* Schenectady, N. Y. When using it, the user may make sure that machines being put to new war work have proper motor capacity. It can help select motors for machines formerly driven from line shafting. It resembles an engineer's slide rule.

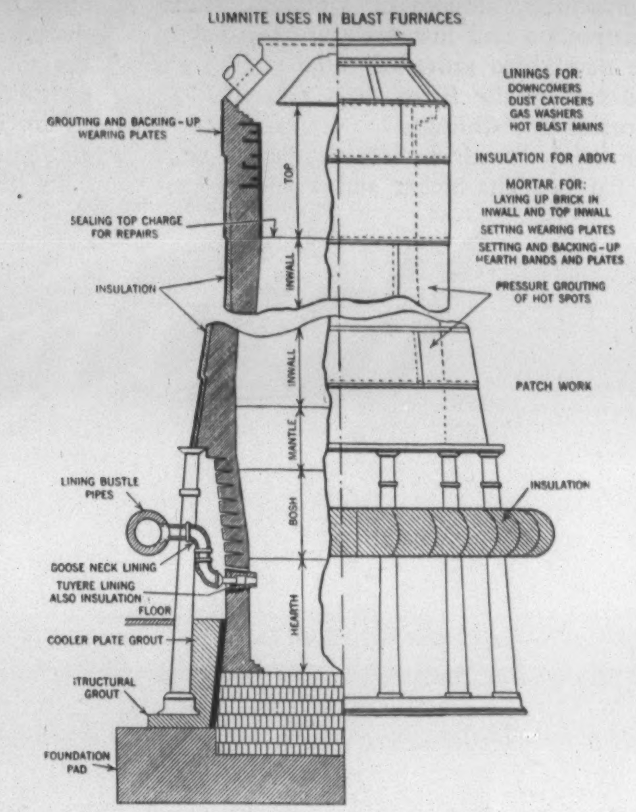
FOR INDUSTRIAL FURNACES ONLY!

War Industries use Refractory and Heat-Resistant Concrete, made with LUMNITE, to save construction time and reduce maintenance work.

IN the furnaces, ovens and kilns of industry, Refractory Concrete, made with LUMNITE, is saving time and reducing cost of war production. It's in furnace walls, linings and arches—in door linings, ducts and flues of coke plants.

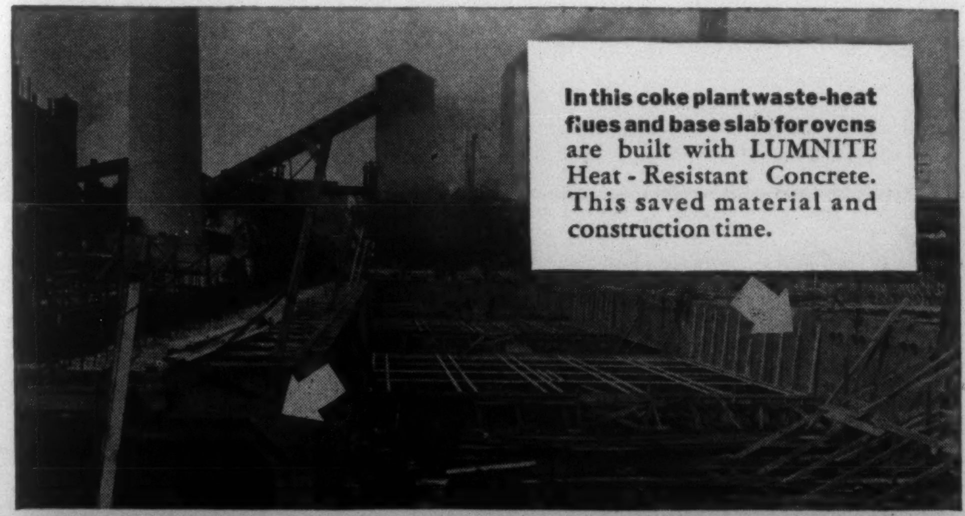
Refractory *Insulating* Concrete is helping to meet the critical need for insulating refractories. Special shapes of Refractory Concrete, quickly made and ready for installation, are eliminating delays in construction and maintenance.

These are some of the ways in which LUMNITE is aiding war production. Because of restriction on sales, it is now available only for essential war uses. For information on the availability of LUMNITE or its most efficient use in your work, write: Dept. M, The Atlas Lumnite Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

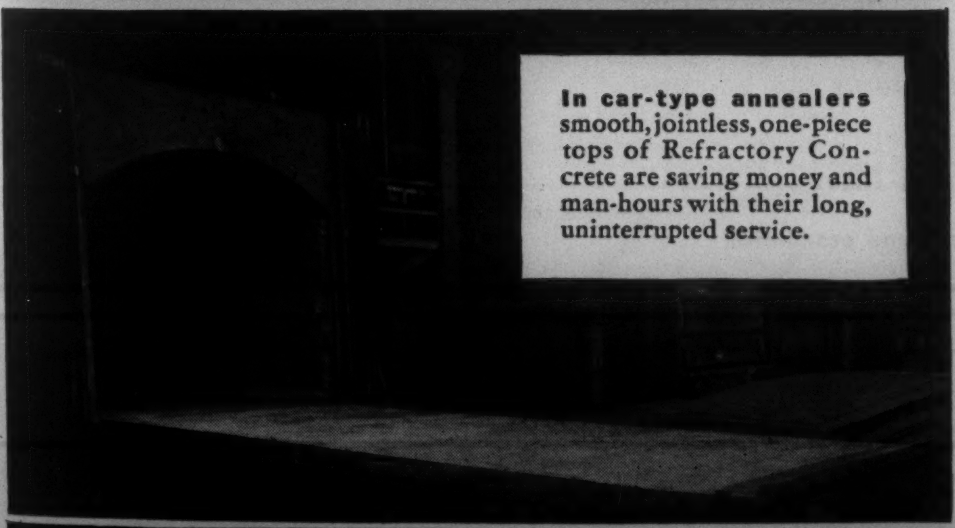

LUMNITE USES IN BLAST FURNACES
GROUTING AND BACKING-UP WEARING PLATES
SEALING TOP CHARGE FOR REPAIRS
INSULATION
LINING BUSTLE PIPES
GOOSE NECK LINING
TUYERE LINING ALSO INSULATION
FLOOR
COOLER PLATE GROUT
STRUCTURAL GROUT
FOUNDATION PAD
TOP
INWALL
INWALL
MANTLE
BOSH
HEARTH
LININGS FOR:
DOWNCOMERS
DUST CATCHERS
GAS WASHERS
HOT BLAST MAINS
INSULATION FOR ABOVE
MORTAR FOR:
LAYING UP BRICK IN INWALL AND TOP INWALL
SETTING WEARING PLATES
SETTING AND BACKING-UP HEARTH BANDS AND PLATES
PRESSURE GROUTING OF HOT SPOTS
PATCH WORK
INSULATION

Major steel companies use Refractory Concrete to avoid delays in maintaining and reconditioning blast furnaces and auxiliaries.

• • •



In this coke plant waste-heat flues and base slab for ovens are built with LUMNITE Heat-Resistant Concrete. This saved material and construction time.



In car-type annealers smooth, jointless, one-piece tops of Refractory Concrete are saving money and man-hours with their long, uninterrupted service.

LUMNITE AVAILABLE

For Essential War Needs Only

The distribution of LUMNITE is under definite restriction in order to aid the War Production Program. Control over shipments is aimed at placing LUMNITE for essential war uses only.

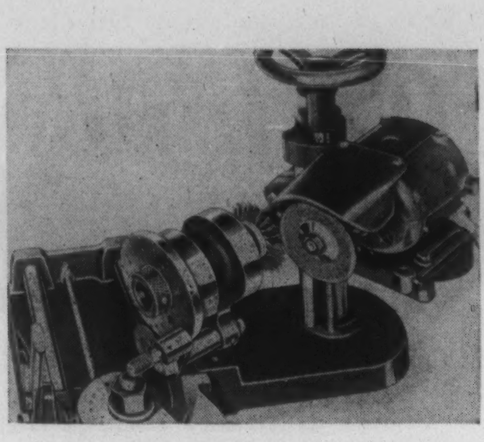
In order to conserve raw materials and supply LUMNITE in sufficient quantities for war needs, we ask that you inform your dealer regarding the intended use of the LUMNITE when you place your order.

LUMNITE FOR REFRACTORY CONCRETE

Universal Cutter-Grinder

Extreme flexibility, quick low-cost setups without disturbance to production grinders, wide cutter range applicability, compactness, absence of vibration, sturdy construction and low price are features of the new Hilco universal cutter-grinder announced by the *Berco Mfg. Co.,* 429 W. Superior St., Chicago.

Furnished with an interchangeable table or flat bed attachment and a special universal index dividing head, the Hilco, regardless of type tool ground last, may be set up in just a few minutes for any other type cutter. It will grind to perfect sharpness any concave, convex, helical, straight, tapered angle or special cutter up to 6 in. in diam., and any saw up to 18 in. in diam., regardless of cutting angle required.



In the accompanying photograph the Hilco cutter-grinder is set up with special index dividing head to sharpen a double angular cutter.

● A new cold-drawing process reduces die friction to an extreme low, permitting the repetition of severe cold work to an extent heretofore thought impossible without intermediate annealing. Under favorable conditions, eight consecutive cold drawing operations have been performed without annealing, whereas the usual practice has been to anneal after each pass. It is known as the process for metallic lubrication of steel, sponsored by *Metlab Company,* 1000 Mermaid Avenue, Philadelphia.

Dust Collecting Benches

To meet the demands of machine tool manufacturers for a device to prevent fine abrasive dust from snagging operations spreading through the shop to injure precision machinery, Wolverine dust collecting benches were brought out by the *Wolverine Equipment Co.,* Cambridge, Mass.

Units then existing were all table height and usually depended on auxiliary equipment to exhaust and collect the dust. Wolverine has brought out a new portable dust collecting bench as low as 20 in. high, convenient for the heavier castings. It returns clean air to the room; therefore no heat is wasted.

CLEAN AND DESCALE . . . QUICKER

Bullard-Dunn Station Type Conveyor unit in a large Machine Tool plant.

● The Bullard-Dunn Process is a "standout" for War Production descaling because it is fast, thorough, dependable, easy to operate and labor saving. It does not etch, therefore causes no dimensional changes. It cleans out holes, renders surfaces chemically clean and is economical. Bullard-Dunn can be conveyorized too, making it possible to handle large production on a timed schedule. Manually operated units, are of course, also available.

Write for bulletin today.

✓ CHECK THESE FEATURES

- Rapid and economical
- Easy to operate
- No dimensional changes
- No etching
- Descales recesses
- Produces chemically clean surfaces
- Can be fully conveyorized
- Long solution life

BULLARD-DUNN Process

DIVISION OF THE
BULLARD COMPANY - BRIDGEPORT - CONN - U - S - A -

Blue-print for Victory
PREHEATED AIR
RECUPERATOR
RECUPERATOR
RECUPERATOR
SECTION C-C
FIRING PORT
WASTE GAS TO STACK
WASTE GAS TO STACK
SECTION A-A
PLATFORM
COLD AIR
PREHEATED AIR
PREHEATED AIR
RECUPERATOR
RECUPERATOR
FUEL LINE
AMCO

More AND *Faster* STEEL PRODUCTION

AMCO PIT FURNACES

Steel is the key to war-time production. AMCO Pit Furnaces are doing their part by serving the largest steel producers in the United States and Canada. Operating reports continually show a substantial increase in steel quality, a decrease in chipping costs and a welcome reduction in scale loss, fuel expense and maintenance costs.

Over 160 in active operation and on order; get the facts.

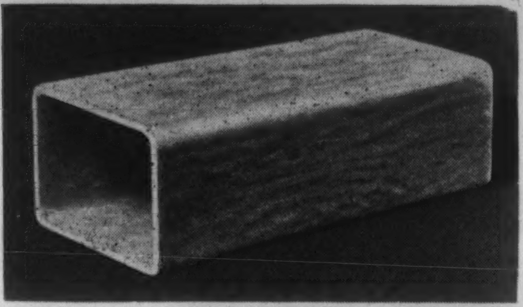
The **AMSLER–MORTON** *Company*

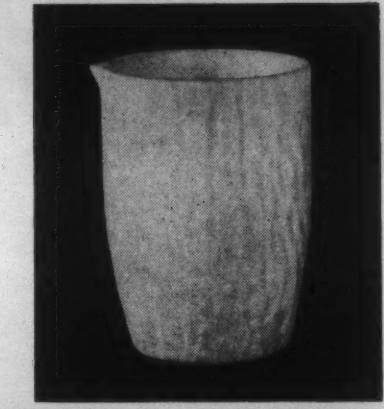
VITREOSIL

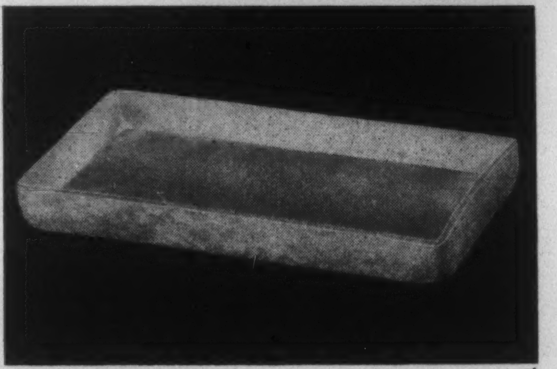
(Vitreous Silica)

The Ultimate
CERAMIC
for

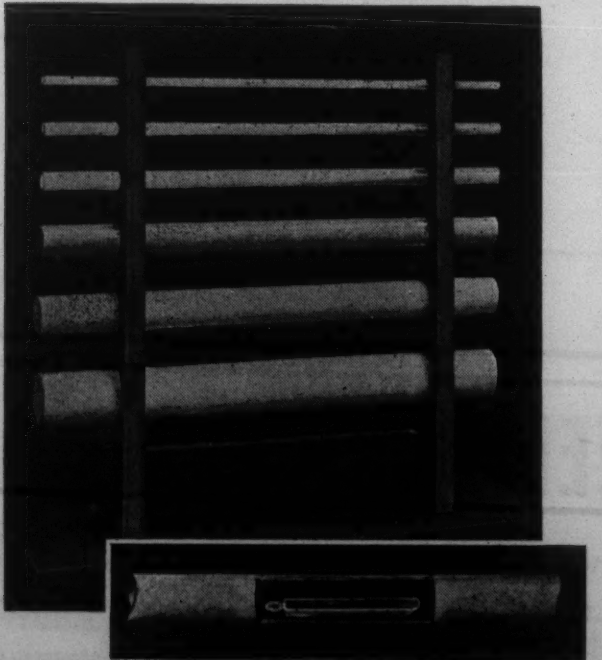
- SINTERING AND CHLORIDIZING
- HEAT TREATMENT OF METALS
- EVAPORATING, CONCENTRATING AND CRYSTALLIZING ACID SOLUTIONS
- CONTROLLED ATMOSPHERE TECHNIQUES
- HIGH TEMPERATURE ELECTRICAL APPLICATIONS
- GAS, COAL AND COKE ANALYSIS
- PRECIOUS METAL REFINING
- METALLURGICAL ANALYSIS AND RESEARCH







VITREOSIL is superior to both glass and porcelain for these and many other exacting applications in metallurgy . . . Vitreosil possesses the highest temperature shock resistance of any ceramic material. . . . It is practically immune to the severest acid conditions, is free from metallic impurities—nonporous—light in weight, and has high electrical resistivity at elevated temperatures. VITREOSIL is suitable for continuous use up to 1000-1100° C.



VITREOSIL is available *without restrictions*, in the following forms:

- CRUCIBLES
- MUFFLES
- RETORTS
- PIPES and FITTINGS
- TANKS
- TRAYS
- IMMERSION HEATERS
- COMBUSTION BOATS
- DRAWN ROD and TUBING

For explicit data and prices, write for bulletins.

THE THERMAL SYNDICATE, LTD.
12 EAST 46th STREET, NEW YORK, N. Y.

Brushes for Cleaning Metal Cavities

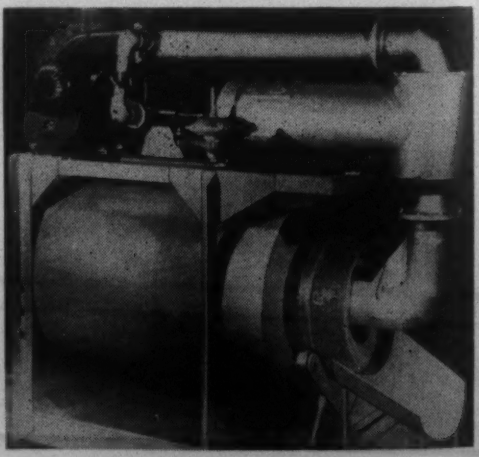
A new brush will clean both the bottom and side walls in the cavities of various machined, stamped, cast and forged parts in one operation. The brushes look like discs with two square corners and rotate like a spinning coin, removing rust, scale, rubber, burrs, sharp corners, dirt and chips from metal holes, cavities and recesses.

They are called "Sibot" brushes and are made by the *Osborn Mfg. Co.*, Cleveland. They may be used by hand, automatically or semi-automatically, and are made of wire in two ringlock sections with a metal shank in between. The brushes may be inserted into the chuck of an ordinary drill press.

Dryer Feasible for Small Parts

A drying mechanism that has a capacity for small steel parts up to 9,500 lbs. per hr. is being introduced by the *Salem Engineering Co.*, Salem, Ohio. Materials may be charged into the Salix dryer by individual feeder equipment, or the dryer may be used in connection with a continuous line of other equipment.

Materials are conveyed through the dryer by an internal spiral screw, which deposits them at the opposite end. They are tumbled as they are dried. Hot air is blown into the interior of the perforated drying drum, thus coming in direct contact with the parts passing through. Automatic temperature control and variable speed drive are included.



War Industries Asked For An *Exceptional* MAGNESIUM Heat Treating FURNACE

"Exceptional performance required."

Today most of the major producers of magnesium use Despatch furnaces because each unit installed gives *exceptional performance*, just as specified. Our insistence on this point works to your advantage in maintaining high quality production.

As a result, when you install a Despatch furnace you have equipment that is particularly suited to the job. And in addition each furnace is thoroughly up-to-date, embodying the very latest construction details as recommended by the nation's best-known magnesium experts.

Thus you receive additional assurance of dependable results when you choose a Despatch furnace. You get exceptional performance always, plus advanced furnace design suited to the newer, tougher jobs of tomorrow.

WIRE OR PHONE today for a Despatch engineer. He will recommend a tested and approved standard Despatch magnesium heat-treating furnace for your plant.

DESPATCH FURNACES MEET THESE HEAT-TREATING REQUIREMENTS

UNIFORMITY ± 5° F. through entire heat range. Latest automatic recording and control equipment aids straight-line heating.

FAST AIRFLOW from larger fans eliminates dead-spots, quickly penetrates heaviest charges. Adjustable ports in heat ducts give absolute control of air distribution.

TIGHT SEALED furnace body and doors allow use of SO_2 gas, cuts heat loss, improves working conditions. All-welded body.

EFFICIENT HEAT suited to all Mg. or Al. alloys. Electric or gas systems (indirect-fired, radiant tubes). Heater mounted outside of work chamber.

SAFETY CUT-OUT Standard limit-controls prevent loss of loads and reduce fire hazards.

PROMPT DELIVERY of 29 standard models, electric or gas-fired.

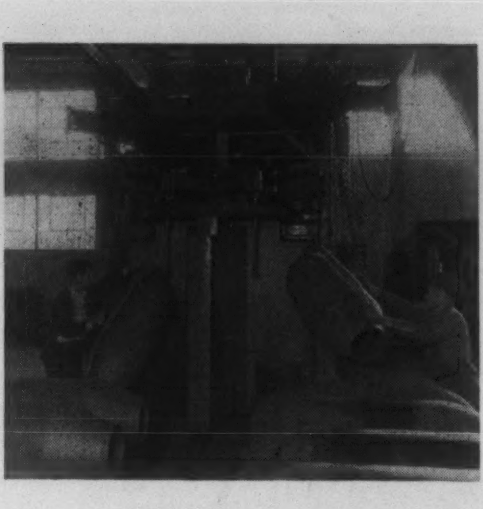
DESPATCH
OVEN COMPANY MINNEAPOLIS

Complete line of
ALUMINUM HEAT-TREATING
FURNACES, FOUNDRY OVENS
Write for details.

Automatic Bomb-Cleaning Machine

As bombs and aerial torpedoes constantly grow larger in size and weight, more exacting equipment must be designed to clean their metal casings from scale and dirt more quickly than ever before. Inspectors can detect flaws more easily after blast cleaning than at any other time.

Pangborn Corp., Hagerstown, Md., has designed a special bomb-cleaning machine. The accompanying photograph shows bombs being loaded onto and unloaded from the special indexing hooks that carry them suspended from the top into the cleaning section of the cabinet where a battery of Rotoblast units uniformly clean the outside surfaces while an airblast nozzle is injected into the inside and thoroughly cleans the interior.



● A new Babbitt metal, "Rex," which conforms to the Tin Conservation order holding tin content down to 12 per cent, has been put out by the *National Bearing Metals Corp.*, St. Louis. Heretofore the base of most severe-service Babbitt metal was about 90 per cent tin. "Rex" is satisfactory for most present uses if the lining is applied properly and the bearings carefully fitted and lubricated.

Complete Except for Lipstick Holder!

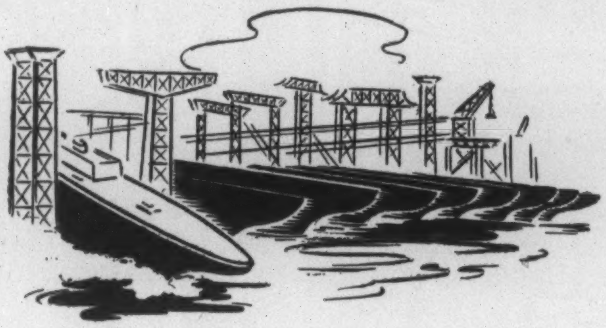
To meet the needs of women welders, *General Electric Co.*, Schenectady, announces a complete line of safety clothing especially designed for the fair sex. Safety, durability and — of course — smart styling are combined.

There are leather sleeves, aprons, jackets, leather gloves, head and hair covering. The head gear was designed by Sally Victor, one of the country's leading milliners, if you please, a protector from sparks and slag.

In the accompanying photograph, notice the regular teeth, the well-shaped nose, the intelligent eyes far apart — but pardon us — we inadvertently digressed. We meant to point out the well-tailored and practical dress, the spark-proof gloves, etc.

● "Cerrosafe" is a low-temperature melting metal to proof-cast cavities such as molds, gun chambers, forging dies, etc. It is a mixture of bismuth, lead, tin, and cadmium. It weighs .35 lbs. per cu. in., and is completely molten at 190 deg. F. It is made by *Cerro de Pasco Copper Corp.*, 40 Wall St., New York.

Ships on the Production Line



ACP Products save time and step-up efficiency in Navy and private shipyards

Just as ACP DEOXIDINE helped make the mass production of automobiles possible . . . and as ACP RODINE boosted the efficiency and volume of steel production . . . so, today, these and other ACP Products are helping build the vital bridge of ships.

RODINE in pickling baths, saves both steel and acid and prevents pitting and burning of plates. It minimizes acid embrittlement, making plates easier to machine, bend and drill. DEOXIDINE is the time-tested acid cleaner. On aluminum ventilating ducts and superstructure sections, it removes oil, eradicates corrosion and neutralizes corrosion-producers. LITHOFORM chemically coats galvanized surfaces to prevent the characteristic blistering and peeling of paint.

All three have long served their apprenticeship with the growth of American Industry.

●

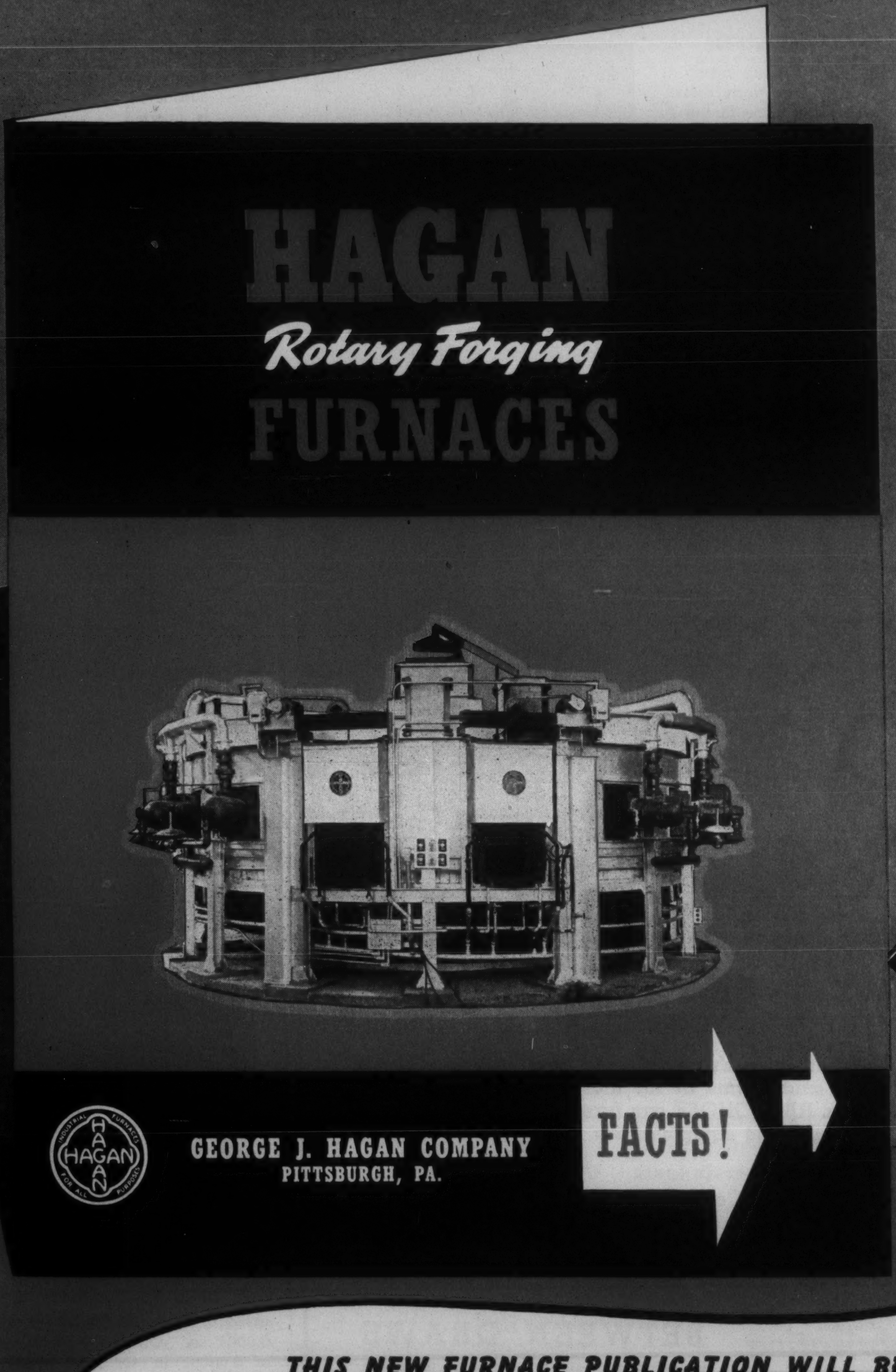
Among the other ACP Products are: FLOSOL, an exceptional soldering flux for steel, brass, copper, tin, terne plate, zinc and galvanized iron; KEMICK, a chemical paint that holds to and protects metal surfaces even when heated to redness; CUPRODINE copper coats steel by simple immersion.

These and other ACP Products are available to you in speeding production of the vital bridge of ships. The experience of the ACP laboratories in metal treating and finishing processes is at your service.

AMERICAN CHEMICAL PAINT CO.
MAIN OFFICE AND WORKS
AMBLER . . . PENNA

CHEMICALS ACP PROCESSES

DETROIT, MICH., 6335 Palmer Ave., E.
CANADIAN BRANCH
WALKERVILLE . . . ONT



HAGAN
Rotary Forging
FURNACES

GEORGE J. HAGAN COMPANY
PITTSBURGH, PA.

FACTS!

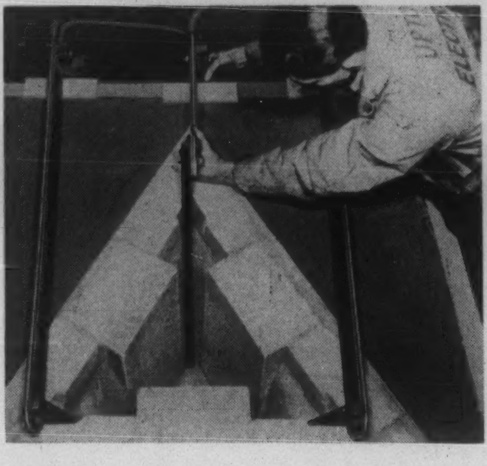
THIS NEW FURNACE PUBLICATION WILL BE OF REAL INTEREST AND VALUE TO EVERY FORGING PLANT EXECUTIVE INTERESTED IN MORE UNIFORM CONTINUOUS HEATING OF STEEL BILLETS.

***YOUR* COPY WILL BE GLADLY SENT ON REQUEST**

GEORGE J. HAGAN C
PITTSBURGH, PA.

Triangular Heat-Treating Furnace

To assure efficient heat treating operation under power supply conditions that ordinarily are considered unsuitable for internally heated salt baths, an entirely new type of electric salt bath furnace has been built by *Upton Electric Furnace Div., Commerce Pattern Fdry. & Machine Co.,* 7450 Melville Ave., Detroit. Besides improved heat distribution, longer pot life and the impossibility of shorting and burning work are claimed.

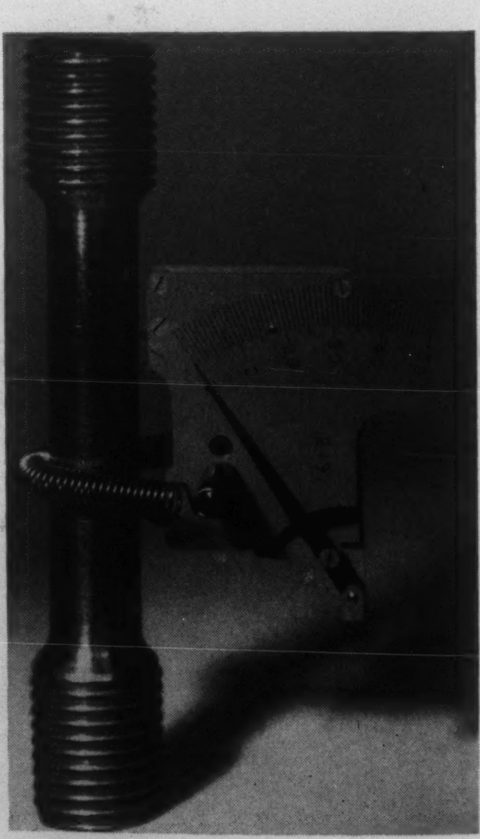


Sometimes power supply is inadequate to permit furnace operation on one phase only of the three-phase supply. The use of three electrodes, one for each phase, solves the difficulty, reduces cost and increases efficiency. With an electrode in each of the three corners of the triangular furnace, each is guarded against direct contact with the work.

● A portable balancing unit, capable of one-man transfer, is offered by *Gisholt Machine Co.,* Madison, Wis. It detects unbalance in large rotating parts of special design without dis-assembly from their parent machines. The unit indicates both phase angle and amplitude of vibration, and from the readings locations where corrective weights are needed are determined.

Strain Gage

The Porter-Lipp strain gage, with strain multiplication factor of about 300 and range of 0.008 in. or better, is introduced by the *Baldwin Southwark Div., Baldwin Locomotive Works,* Philadelphia, for structural testing.



Weighing only 0.4 oz., overall dimensions are 1¾ x 2 in. x ⅝ in. Each graduated division corresponds to a strain of 0.0001 in., and has a readable accuracy of 0.00002 in. for gage length of 1 in. It is claimed superior to gages previously imported from Europe.

● For extreme toughness a water-hardening tool steel, "Jessop RT," is now furnished by *Jessop Steel Co.,* Washington, Pa. It is outstanding for "battering tools." It will stretch over 4 per cent before it will break. Properly treated, it will have a breaking strength of 323,000 lbs. per sq. in. and elongation in 2 in. of 4-5 per cent.

ARE YOU CHANGING OVER FROM BRASS TO ?

STEEL SHELL CASES

RANSOHOFF

IS READY RIGHT NOW WITH THE RIGHT EQUIPMENT FOR YOUR CLEANING PROBLEMS

Whether you're producing shell cases for small arms or for those block busters, RANSOHOFF can furnish you most dependable equipment for

1 *Cleaning* BEFORE ANNEALING

2 *Pickling* AFTER ANNEALING

3 *Lubricating* BETWEEN DRAWS including all methods of surface treatment

4 *Bonderiting & Parkerizing* finished cases

Start right in '43 with RANSOHOFF EQUIPMENT . . . thorough, quick, economical. Used successfully in victory-minded plants from coast to coast. Write the RANSOHOFF ENGINEERS TODAY.

N. RANSOHOFF, Inc.

1313 TOWNSHIP AVE., CINCINNATI, OHIO

McKAY ELECTRODES HELP LAUNCH 'EM AHEAD OF SCHEDULE!

WILLIAM B. GILES
THE MAGIC WAND OF WELDING
McKAY
SHIELDED
ARC
ELECTRODES

The McKay line includes regular carbon steel, stainless, and alloy steel electrodes for every welding purpose. Literature on request.

The modern miracle of the "7-day cargo vessel" is an actuality made possible chiefly by welding. As dozens of these sleek all-welded hulls slip down the ways on coast lines all over America, remember that McKAY Shielded-Arc Electrodes have contributed greatly to this accomplishment.

Virtually the entire output of McKay Electrodes is now required ot satisfy the growing demands of war. Carload after carload moves out not only for marine construction but for a multitude of other vital uses where the advantages of the "researched Electrode line" have been demonstrated. The McKay Manufacturing Policy—"Every Electrode a leader in its class."

ARMY E NAVY

Among the first honored with the Navy "E", The McKay Company is proud of the broader award of the Army-Navy "E".

THE McKAY COMPANY • PITTSBURGH, PA.
PACIFIC COAST SALES OFFICES: 125 S. Santa Fe Ave., Los Angeles • 100 Howard St., San Francisco

McKAY WELDING ELECTRODES
AND INDUSTRIAL, MARINE AND AUTOMOTIVE CHAINS

New A.C. Welder

The "Bumble Bee" is the imaginative name of a new a.c. welder of the *Wilson Welder & Metals Co., Inc.*, 60 E. 42nd St., New York. The most interesting feature is its low open circuit voltage of 42 volts, automatically and positively maintained. Two primary coils are used instead of the usual one, with a magnetic contactor in the circuit of one primary.

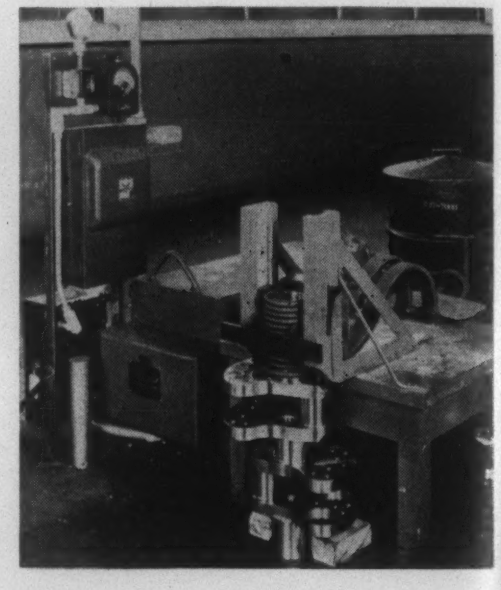
Power factor correction is provided with built-in capacitators on all four sizes—300, 500, 750 and 1000 amps.—resulting in a power factor of 100 to 86 per cent (lagging) over the popular working range. Capacitators are cut out when the machine is idle.

The welder is portable and streamlined, and its 18 in. width permits passage through narrow doors.

● Formerly the copper deplating of iron and steel scrap was costly, and most of the copper was wasted. A new method has been developed by the Electroplating Div., E. I. duPont de Nemours & Co., Inc., Wilmington, Del. Now virtually 100 per cent of the copper is recovered in a form satisfactory for direct use in electroplating important metal parts for military equipment; also, much strip steel and iron may be available for reuse. Copper deplating takes place without attack of the base metal.

Induction Heating Aircraft Crankshafts

In the accompanying photograph is shown a new use for the a.c.f. Berwick electric metal heater transformer. Here it is installed in an aircraft factory where, by induction, they are heating a steel crankshaft $9\frac{7}{8}$ in. long, $4\frac{1}{4}$ in. outside diam., with a tapering hole that starts out with $3\frac{3}{4}$ in. inside diam., attaining a heat of around 400 deg. F. in 3 min.



In the top end of this shaft and in the lower end frozen bushings are inserted. An expansion of between .010 and .011 in. of the part heated is obtained, sufficient to insert the parts that are desired to be shrunk together. The equipment is made by the *American Car & Foundry Co.*, 30 Church St., New York.

Lay-Out Dye for Sheet Metal

For performing accurate layout work on sheet metal, impossible with a lead pencil, a new product has been developed by the *Acme White Lead & Color Works*, 8250 St. Aubin Ave., Detroit.

It is a lay-out die, semi-transparent, extremely fast drying and purple in color, which is brushed upon the sheet. It dries in a minute. Then the layout is scribed on the stock with a sharp-pointed stylus, nail, or similar tool. The lay-out stands out bright and clear.

When work is completed, the surplus dye may be washed off with a rag soaked in denatured alcohol.

DESCALING TIME CUT

...ANOTHER BOTTLENECK BROKEN WITH FERRISUL

HERE is another case of time saved and costs cut on an important war job by chemical cleaning with Ferrisul (anhydrous ferric sulfate).

A manufacturer of stainless steel exhaust manifolds for aircraft engines is removing annealing scale from crates filled with these small, irregularly shaped parts with Ferrisul in less time than it would take to clean one or two pieces with mechanical methods!

Ferrisul is specified for this job because it removes scale quickly and thoroughly with practically no attack on the base metal. This not only saves precious metal that might be lost by other methods, but on this particular job where hair-line accuracy is absolutely essential, any significant attack on the metal by the descaling operation might cause a costly percentage of rejects.

Dry and granular, Ferrisul is safe and easy to handle and store. It is helping to solve wartime metal cleaning problems in hundreds of plants on scores of different ferrous and non-ferrous alloys.

For full information and technical advice on *your* metal-cleaning problems, inquire: MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston, Massachusetts.

MONSANTO CHEMICALS
SERVING INDUSTRY...WHICH SERVES MANKIND

THE NAVY TAKES "JAVA"

hot out of urns brazed with EASY-FLO!

YES, Easy-Flo's contribution to the war effort extends even to the making of coffee urns for the Navy. Above you see some large Monel urns in the making. Bottoms are brazed to the shell with Easy-Flo and the tops are brazed to a reinforcing ring.

Easy-Flo also helps to make other equipment essential to the health and comfort of our fighting men, including field kitchens, cook stoves, food refrigerators, air conditioners and the like.

And when it comes to fighting equipment, this low temperature silver brazing alloy is doing hundreds of metal joining jobs involved in making planes, ships, tanks, guns and shells.

To all this wide variety of work Easy-Flo brings the exceptional speed with reliability and economy that made it a leader before the war, among brazing alloys used by industry.

If your war effort includes the joining of ferrous, non-ferrous or dissimilar metals, particularly where joints must be strong and leak-tight, step up your production with Easy-Flo. We'll be glad to help you get started.

GET FULL DETAILS IN BULLETIN 12

This bulletin gives you the reasons for the speed, reliability and economy of Easy-Flo brazing and shows you how easy it is to put this free-flowing, fast-acting alloy to work in your plant. Also contains much useful information about joint designs, heating methods and production procedures. Write for a copy of Bulletin 12 today.

HANDY & HARMAN
1867
75th
ANNIVERSARY
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ARMY E NAVY

News of Men, Societies, Meetings and Companies

Briefs on Societies, Promotions, Education

"Save Those Tools" is the subject of a one-reel, black and white, sound picture recently released by *International Harvester Co.*, 180 No. Michigan Ave., Chicago. The picture shows how Harvester's tool salvage program was organized, and its functioning methods from salvage at individual plants to the central clearing house for the utilization of excess and obsolete tools. Emphasis is given to low-temperature brazing of damaged tools. Regrinding to smaller sizes or reworking to different types are given attention.

In perfecting the modern process for induction hardening, it is possible to maintain the correct structure of the metal core and to practically eliminate scale formation and distortion, stated Dr. H. B. Osborn, Jr., chief research engineer of the Ohio Crankshaft Co., *Cleveland, before the Electrochemical Society in Cleveland. In today's mass production, the exact duplication of electrically heat-treated parts can be maintained automatically, thus eliminating possible rejects resulting from WPB's rigid inspection and test requirements. Hardening machine units are designed to be located directly in production lines.*

The annual apprentice molding and pattern-making competition of the *American Foundrymen's Association* will be held in 1943, the contest to be in connection with the Society's convention at St. Louis, April 28 to 30. The following divisions will be represented: gray iron molding, steel molding, non-ferrous molding and pattern-making. Prizes of $40, $20 and $10 will be awarded. Such competitions started in 1924. Last year apprentices from some 80 or more of the best known industrial plants of the country participated.

As many as 75 shops in and around Newark, N. J. have been assisted in their pressing metallurgical and production problems by New Jersey's War Products Advisory Committee, formed by the New Jersey Chapter of the American Society for Metals. *This was made known by Dr. Norman E. Woldman, chief metallurgical engineer of Eclipse-Pioneer Div., Bendix Aviation Corp., Bendix, N. J., chairman of the Advisory Committee, in reviewing the first nine months of the committee's service.*

A field research project to study the possibility of utilizing cast iron in operations at elevated temperatures (in excess of 450 deg. F.) has been approved by the *War Production Board*. Engineers, foundrymen, field service men and others who have information on performance records are asked to report to the War Metallurgy Committee, National Academy of Science, Washington, D. C., through either T. E. Barlow, 2440 Book Bldg., Detroit, or C. O. Burgess, 4625 Royal Ave., Niagara Falls, N. Y.

Submarines into Oyster Beds!

Not only will we turn swords into ploughshares but submarines into oyster beds at the end of the present world conflict. When the American Navy salvaged German submarines wrecked along our eastern coast they found them covered with a fine crop of young oysters, scallops, wing shells and other marine life. More than 10,000 such fish items were found clinging to each wreck examined.

So, when we beat Germany, let's incorporate in peace plans provision for Germany to send their surviving submarines to our Coasts and sink them. With these submarines providing food for Friday tables these underwater snakes would at last be performing constructive work.

A greatly expanded program for research and collateral projects of the American Foundrymen's Association *has been decided upon as a result of the establishment of a foundation that will seek an initial fund of $1,000,000. A "community chest" method for financing has been proposed tentatively. The first two or three months of 1943 will be devoted to preparatory work with active campaigning starting in early spring.*

Since 1901, when the apprentice training course of *General Electric Co.* was started, there have been 2,524 graduates; 1400 are still with that company. Only 4 per cent are doing work entirely foreign to their original training.

Twenty-five thousand high school principals and teachers have been invited to take part in a nation-wide search among the country's 1,650,000 high school seniors for the 40 most talented young scientists of that age in America. These 40 will be assigned $14,000 in scholarships and attend a 5-day Science Talent Institute at Washington in February. The movement is sponsored by the Westinghouse Electric & Mfg. Co., *East Pittsburgh, Pa.*

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America's First Transparent Sulphurized Metal Working Lubricant

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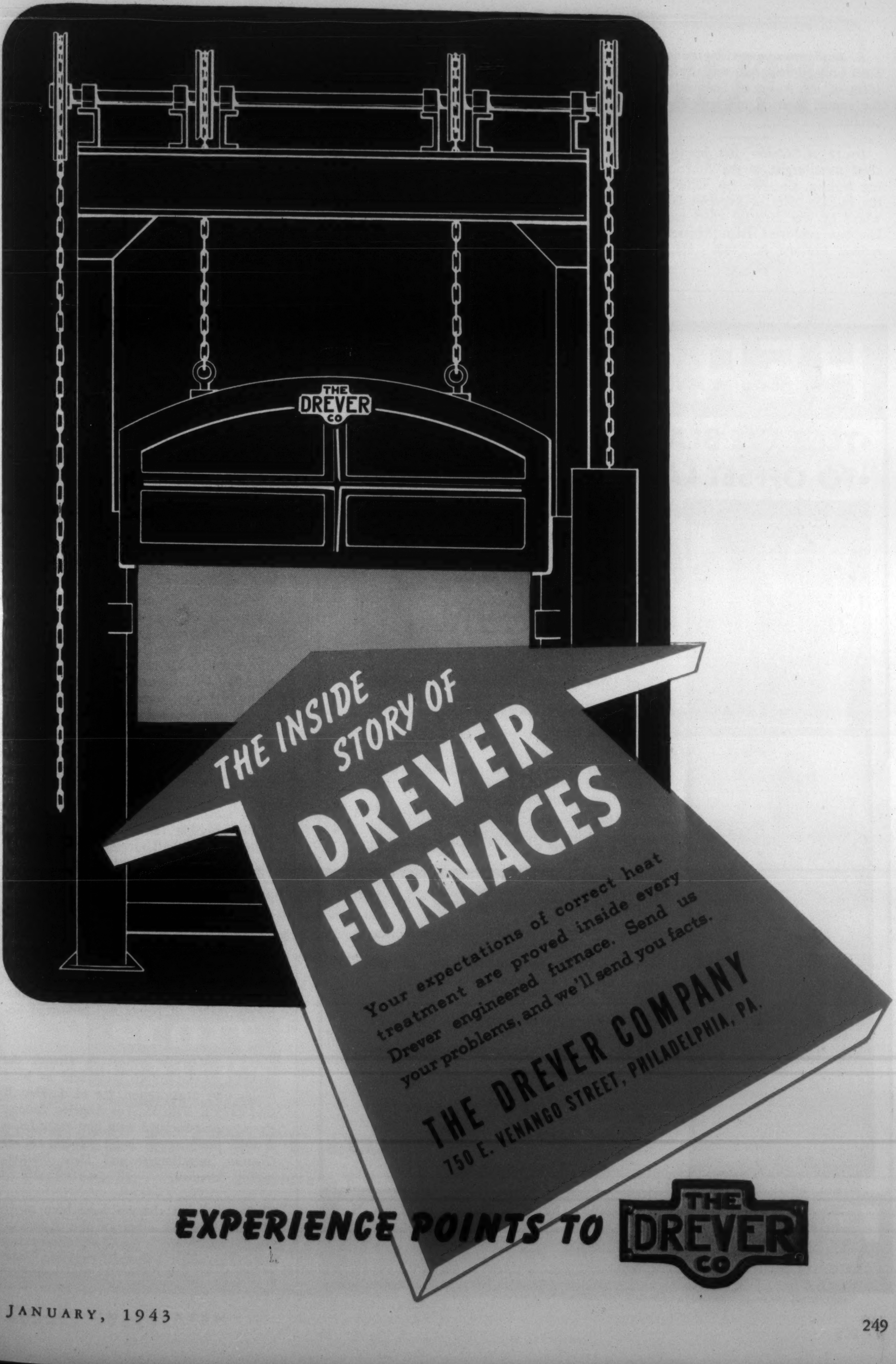

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EXPERIENCE POINTS TO THE DREVER CO

News of Metallurgical Engineers

R. E. Zimmerman, vice-president, U. S. Steel Corp., Pittsburgh, was re-elected president of the American Standards Assn. at the annual meeting in New York in December.

Irving A. Oehler has been appointed chief metallurgist of the American Welding & Mfg. Co., Warren, Ohio. He left the Buffalo office of Republic Steel Corp., where he was assistant chief metallurgist. He was graduated from Rensselaer Polytechnic Institute in 1932. He has both taught in the University of Buffalo and contributed articles to technical publications.

Charles L. Huston, Jr., director of personnel relations, Lukens Steel Co., Coatesville, Pa., has been appointed assistant to the president with that company. He joined Lukens after serving ten years with the American Rolling Mill Co., Middletown, Ohio, five years of which were spent in the metallurgical department.

A. H. B. Jeffords, management engineer with Trundell Engineering Co., Cleveland, has been made vice-president. He will specialize on war production rules and requirements. He has had wide industrial experience, including that in the telephone, explosives and aircraft fields.

Earl S. Patch has been appointed mechanical engineer in charge of application engineering with Henry L. Crowley & Co., West Orange, N. J. He will deal with users of high-frequency iron powder cores and the steatite or ceramic materials. He was formerly with General Motors, and in his new post will concentrate on powder metallurgy.

A. H. Philpot, metallurgical engineer, has been appointed by Copperweld Steel Co., Warren, Ohio, to manage the Washington district office where he will be active in the sale and application of the company's alloy and tool steels.

Harry Crump has joined Carboloy Co., Inc., Detroit, as assistant to the sales manager. He has been with General Electric Co. at Schenectady for 26 years, and since 1929 has been development engineer on carbide tool applications and development. He was chairman of the Schenectady chapter of the American Society of Tool Engineers for the current year.

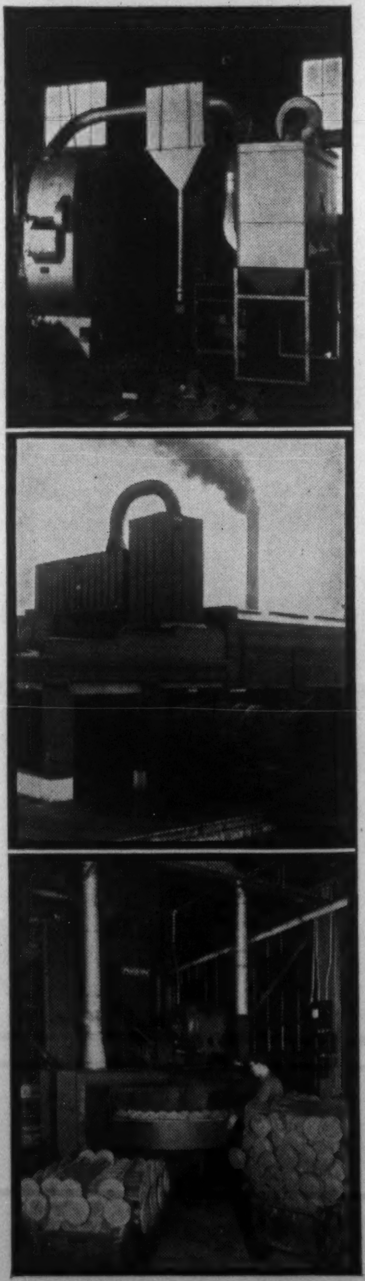
Chester V. Nass has joined Pettibone Mulliken Corp. as manager of its foundry division. During the past six years he has been assistant general superintendent of the Beloit, Wis. foundries of Fairbanks, Morse & Co. He has published many technical articles on foundry methods. He belongs to several committees of the American Foundrymen's Association.

Dr. Walter R. Meyer has become technical director of the Enthone Co., New Haven, Conn. He will direct development of new products and processes for the metal finishing industry. He received his Ph.D. in 1938 from the Department of Metallurgy, Yale University. From 1931 to 1938 he was electrochemist and metallurgist of the General Electric Co., Bridgeport, Conn. For four years he was editor of "Metal Finishing" magazine.

H. A. Erickson, an expert consultant on finishing problems, has become sales engineer in parts of New York and Pennsylvania for the Watson-Standard Co., Pittsburgh, maker of paints and industrial finishes.

H. L. Harvill, pioneer in aircraft die castings, has re-entered the field as head of his own organization, the H. L. Harvill Co., 2223 E. 37th St., Los Angeles. Among those to be associated with him are *Adolph Oswald,* permanent mold design, *S. I. Gleason,* metallurgist and *Dale Norton,* casting foreman.

Three personnel changes have been made at the Cleveland office of the American Steel & Wire Co. *Cecil W. Guyatt* has been made chief industrial engineer. *John S. Conant* has become priorities engineer,



HERE'S HOW

•TO SAVE BLAST CLEANING POWER•
•TO OFFSET LABOR CONSCRIPTIONS•

IN 1943

As we close the record on transactions of 1942 we are grateful that Pangborn Blast Cleaning and Dust Control equipment has been able to successfully help so many plants reach their production goals of the year.

As a preview of 1943 we tell you that our own production of equipment will increase, delays in delivery will be shortened, our equipment performance will be improved as quickly as advances are suggested by the finest engineering skill obtainable, and service to our thousands of customers given honestly, promptly and with only one end in mind—*TO HELP WIN THE WAR IN 1943!*

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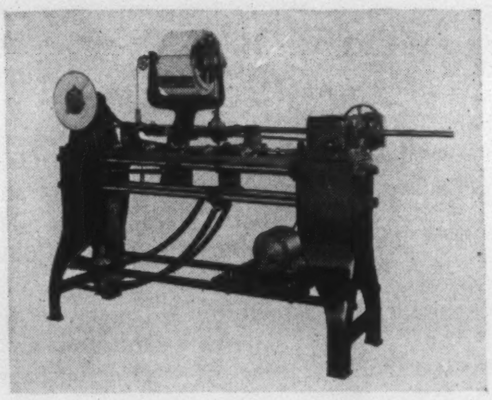

Model Q-7 Scott Tester. Heavy duty wire tester with capacity of 2,000 lbs.

The use of *Scott Testers safeguards your entire routine right through purchasing, manufacture and acceptance-inspection. Our machines are made in some 60 models, with capacities from the finest filament wires to 2,000 lbs. tensile. Numerous advantages are featured in Scott Testers, one of the most useful of which is recording of results on "picturized" charts which are easy to read and compare, and highly useful in facilitating acceptance. Let us send you bulletins.

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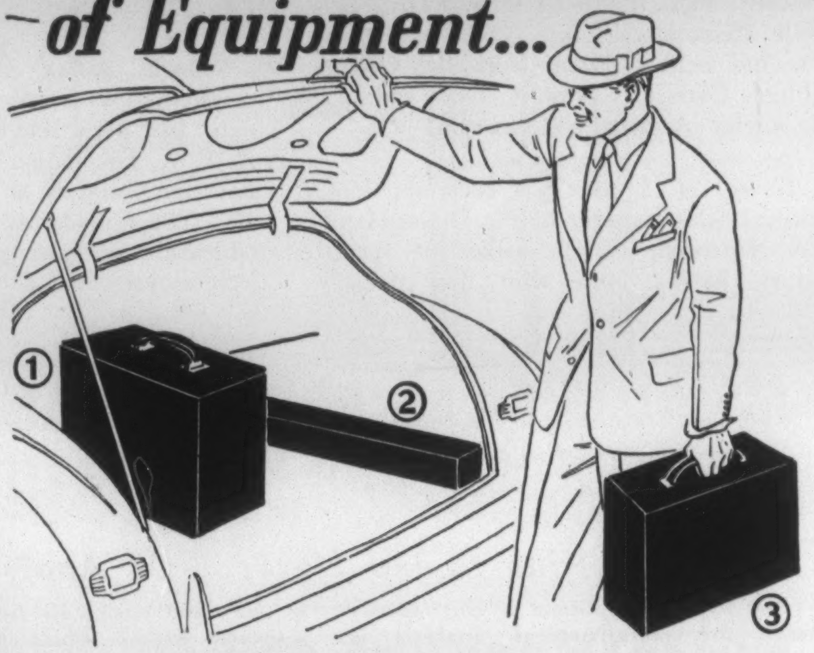

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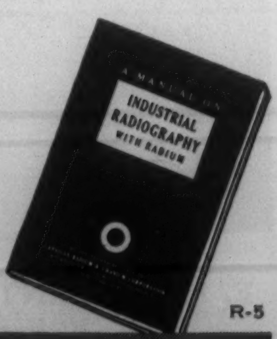
This manual provides a reliable textbook on the fundamentals and technique of modern Industrial Radiography of metals with radium. Specially prepared for the metals industry by our research and technical staff. Write for a free copy of this valuable book.



R-5

Canadian
RADIUM & URANIUM
Corporation
630 FIFTH AVENUE · ROCKEFELLER CENTER · NEW YORK

continuing also as general supervisor of production planning. *Lloyd W. Hackley* has been named assistant general supervisor of production planning for the entire company.

Karl F. Smith has been named to the research staff, Industrial Physics Div., Battelle Memorial Institute, Columbus, Ohio. He has held positions with the Owens-Illinois Glass Co., Newark, Ohio and Carl J. Kiefer Associates, Cincinnati.

George A. Lennox has been appointed general sales manager of the Driver-Harris Co., Harrison, N. J., maker of special alloys, having been with the company since 1907. *Joseph B. Shelby* has been appointed assistant sales manager, having previously been manager of the foundry.

John Howe Hall has given up consulting work and has joined General Steel Castings Corp. as metallurgist.

John W. Bolton, director of metallurgical research, The Lunkenheimer Co., Cincinnati, has been selected to give the first A. F. A. Foundation lecture at the annual Foundry Congress at St. Louis, April 28-30. The Foundation Lecture has been established to have outstanding technical lectures presented to the foundry industry covering important metallurgical developments and trends of the casting industry. Mr. Bolton has been continuously engaged in metallurgical and research work since he was graduated from Rose Polytechnic Institute, Terra Haute, Ind. in 1918.

More Engineering Courses Accredited

Notre Dame and the University of Toledo have been added to the list of United States colleges whose engineering courses have been accredited by Engineers' Council for Professional Development, joint agency of 8 engineering societies in the United States and Canada.

At Notre Dame, curriculae aeronautical, civil, electrical, mechanical and metallurgical engineering have been accredited; at the Toledo school, the course in general engineering.

Additional curriculae have been accredited at 12 other colleges. One-third of the 20 new curriculae accredited are in chemical engineering. A total of 577 engineering curriculae in 131 colleges have by now been accredited.

Plants and Slants

A wire "umbrella" to shield vital explosive plants and oil storage centers from lightning has been developed by Dr. Gilbert D. McCann, engineer of the *Westinghouse Electric & Mfg. Co.* It is already being used by some war industries and one huge ordnance plant. The shield consists of a steel wire strung above the building to be protected and anchored on tall wood poles at each end. The wire is then connected to steel rods buried in the ground. Previously, such plants were guarded by lightning rods, which needed 250 lbs. of copper. The new umbrellas need only 60 lbs. of steel and two wood poles.

U. S. Steel Corp. subsidiaries are now engaged in the greatest program of plant expansion in the history of the Pittsburgh district. It will cost $289,000,000 — 66 per cent of which is for the account of the Government. Vast expansions are to be carried on at the Homestead, Duquesne and Edgar Thomson Works, and will start operating the first half of 1943.

Up to the end of November, not a single working day has been lost at the *Willy-Overland* plant, Toledo, Ohio, either through labor trouble or material shortage since Pearl Harbor.

WPB ordered immediate stoppage of all work incidental to the construction and equipment of the $45,000,000 expansion for the *Continental Ordnance* plant at Hammond, Ind., though the value of construction already in place is $1,000,000. The plant was to have produced and machined heavy steel castings. The abandonment was in line with the policy to rebalance our arms production program.

The Hydro-Arc Furnace Corp., builder of hydraulically-controlled electric arc melting furnaces, has opened a new plant at 561 Hillgrove Ave., La Grange, Ill. The furnaces are used for cold-melting steel

METALLURGICAL PRODUCTS ANALYZED SPEEDILY AND ACCURATELY

Slomin High Speed Electrolytic Analyzers

The rapid acceptance of this instrument for metallurgical analysis is outstanding endorsement of its proven ability and consistent reliability. Over 700 Slomin Analyzers are now in use in metallurgical laboratories.

Electrode design, current efficiency and improved procedures reduce deposition time formerly required by other systems as much as 25 to 40%. Under these high speed conditions hard, smooth, bright and closely grained deposits that firmly adhere to the electrodes are produced, thus assuring good reproducibility of results. Users report an accuracy of 0.01 to 0.04% for routine determinations.

Each model is portable and enclosed in a welded steel case finished in acid resistant baked white enamel. The brushless motor is vapor tight and is therefore unaffected by corrosive fumes.

Both models have an electrically heated, rheostat controlled beaker platform for adjusting solution temperatures, and voltmeters and ammeters so that detailed studies can be made.

Each position of the two place analyzer is a complete circuit that operates independently of the other. Consequently this unit can be used for the simultaneous determination of two samples having widely divergent characteristics.

A laboratory manual of high speed electrolytic methods of analysis written by G. W. Slomin is supplied with each analyzer. Individual copies are available at $1.50 each.

- **S-29460 Slomin Electrolytic Analyzer. One position.** 5 Ampere Model, with Heating Plate. For operation from 115 volt, 60 cycle circuits. Each **$155.00**
- **S-29462 Ditto.** But for operation from 230 volts, 60 cycle circuits. Each .. **$160.00**
- **S-29465 Slomin Electrolytic Analyzer. Two positions.** 5 Ampere Model with Heating Plate. For operation from 115 volt, 60 cycle circuits. Each **$275.00**
- **S-29467 Ditto.** But for operation from 230 volts, 60 cycle circuits. Each .. **$285.00**

HIGH SPEED ELECTRODES FOR USE WITH SLOMIN ELECTROLYTIC ANALYZERS

- **S-29632 Corrugated Platinum Anode** (Patent pending). Price subject to market.
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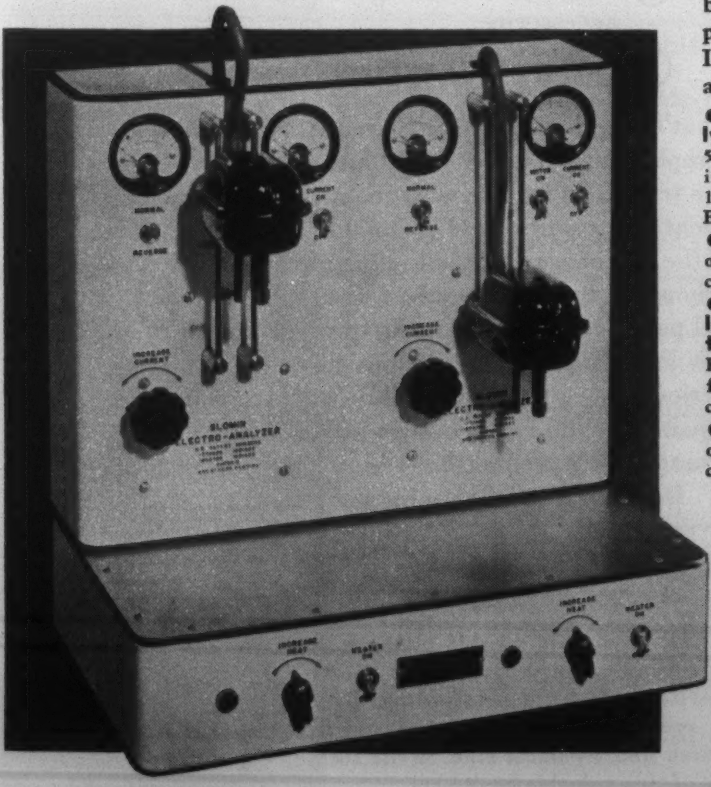

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Quick, Non-Destructive Test for Identification of NICKEL in Alloy Steel

The new Bowser-Morner Test Kit is an invaluable tool for differentiating between nickel alloy and other alloy or plain carbon steels . . . Employing the reagent "spot" test principle, it is simple to use and provides fast, positive recognition of as little as .20% nickel in stock or scrap alloy steel.

Complete Kit, with full instructions and sufficient material for a minimum of 500 tests, is priced at $12.50 (F.O.B. Dayton)

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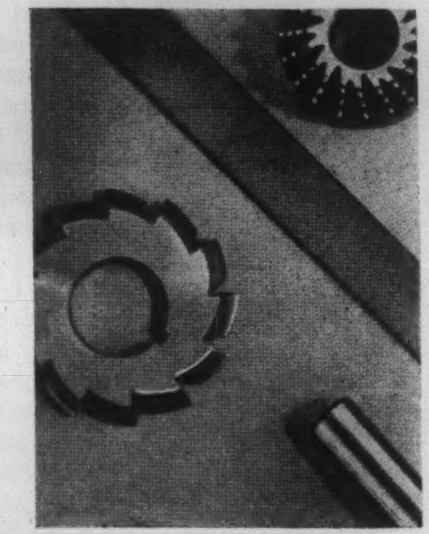

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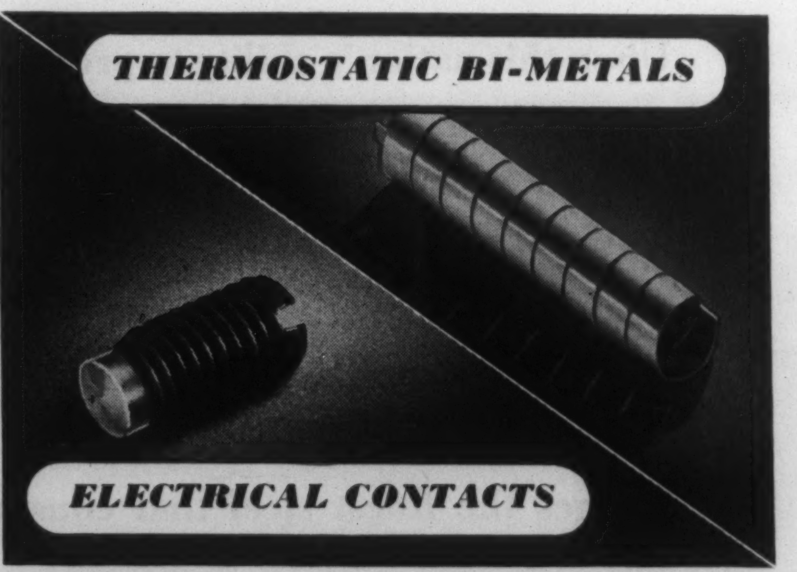

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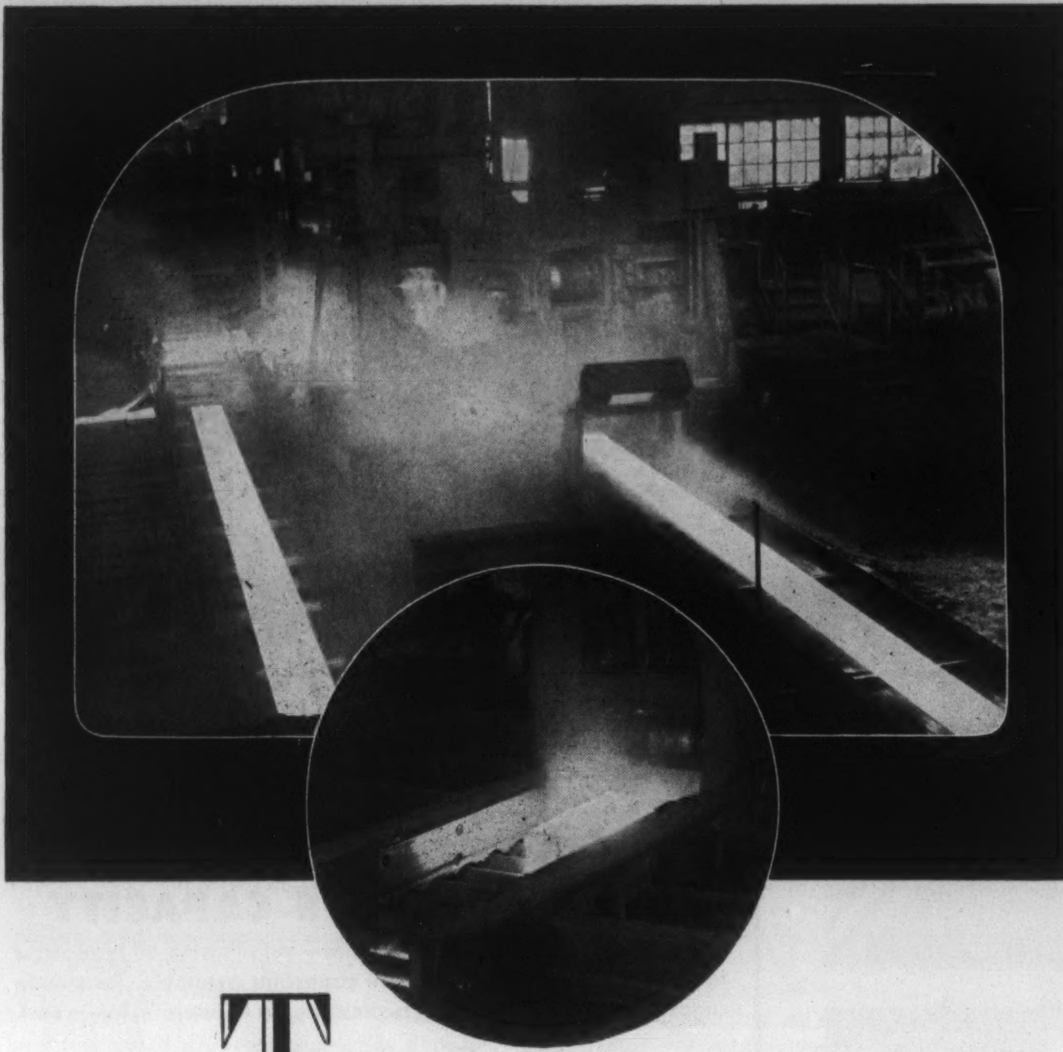

THE HOPE OF THE WORLD

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Upon this nation's ability to produce high grade steel in ever-increasing amounts, depends the hope and security of peace-loving peoples everywhere. To those manufacturing the sinews of war or the needs of a peacetime world, Andrews pledges the finest steel that constant research and production skill are able to achieve. Manufacturers everywhere may rely implicitly upon the high quality of steel for which Andrews has been famous for over 50 years.

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THE NEWPORT ROLLING MILL COMPANY
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and iron or triplexing steel in Whiting Corporation's new converter process.

The first new blast furnace in the Chicago district since the war began was lighted November 16th, the No. 6 furnace of the *Inland Steel Co.* at Indiana Harbor. It replaces one of the older stacks. The company's five other blast furnaces have been operating at maximum capacity since August, 1940, each producing about 1,000 tons daily.

It is said that there is hardly a war material that *Duriron Co., Inc.,* Dayton, Ohio, which won the Army-Navy "E," is not contributing equipment for. Its roster of contributions ranges at least from "A" to "V" — from ammunition to vitamin concentrates for soldiers. Its high-silicon iron and stainless steel equipment have almost universal application.

In a brochure published by *General Motors Corp.* for its stockholders, are listed several instances where materials substitutions have been used and where new designs or new methods have shortened the production time. Thus, stronger, lighter propellers are being built by substituting hollow steel construction for solid aluminum blades. Savings are: 100 to 200 lbs. of aluminum per propeller, and 75 lbs. in weight of complete assembly.

The National Tube Co., U. S. Steel Corp. subsidiary, shipped the last pipe for a 550-mile line in the Long View-Norris City leg at mid-November. Altogether, 137,500 tons of steel was transformed from ingots to tubes, or 4,600 gondola carloads.

American Gas Furnace Co. has announced Ohio agencies as follows: J. E. von Maur, 63 S. High St., Columbus, and 715 Prospect St., Cleveland; Verkamp Corp., Cincinnati.

Meetings and Expositions

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. January 11-15, 1943.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting. New York, N. Y. January 20-21, 1943.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, annual meeting. Cincinnati, Ohio. January 25-27, 1943.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter convention. New York, N. Y. January 25-29, 1943.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York, N. Y. February 14-18, 1943.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting. Buffalo, N. Y. March 1-5, 1943.

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trends

By Edwin F. Cone, Editor

Long-Time Creep Tests

A 100,000-hr. creep test has just recently been completed by the General Electric Co. It was carried out during 11 yrs., the 100,000-hr. period. Four rods of nickel-chrome-molybdenum steel (SAE 4340) were subjected at 842 deg. F. to constant stresses of 13,000; 17,000; 21,000 and 25,000 lbs. per sq. in., respectively. This is said to be the longest creep test on record. Ordinarily creep tests are run for only 1,000 to 3,000 hrs.

Steel Plates

New records in steel plate output, needed for ships and other war material, are frequently being made. The Steel Corporation announces that its 30-in. universal plate mill at the South Chicago Works brought its 1942 production on Armistice Day to 385 tons more than its entire 1941 output. In 1941 this mill topped its best previous year's production by almost 1,000 tons and registered a gain of more than 75 per cent over its 1940 total.

Bessemer Steel

Attention is called to the fact that "since April, Bessemer steel output has been about 80 per cent of capacity," while open-hearth and electric furnace output has been much higher. Whether this poor showing of the Bessemer output is due to lack of demand, lack of sufficiently high priorities, or to the use of more Bessemer metal in open-hearth furnaces is to be investigated by the WPB.

Australian Magnesium

One of the outstanding events of the year in Australia is the reported commencement of the manufacture of magnesium in Newcastle, New South Wales.

More Aluminum Forgings

The production of aluminum alloy forgings, according to a statement by the Aluminum Co. of America late last year, was at a rate 25 times that of 1938. This was a comparatively new industry when the war started but "it is now second to none in the aluminum field." As many as 150 different types of aluminum forgings are used in a single fighter plane; big bombers may have as many as 300.

Sponge Iron

One large company, the Republic Steel Corp., is reported to have authorized the building of a $450,000 plant to make sponge iron from its high-grade magnetic iron ores in Northern New York. The reducing fuel is said to be coke-oven gas and the output 100 tons per day. The projected use of this product is "in electric furnaces to make high-quality alloy steels."

This is the first definite project recently to make sponge iron on a commercial scale. Some 20 years or more ago several such projects were active but never developed into a successful commercial enterprise.

Steel Ingot Output

Reliable estimates place the steel ingot output of the country at about 87,000,000 net tons for 1942 with the rated plant capacity not exceeding 92,000,000 tons. The actual steel production for 1943, according to the best estimates available "is likely to be in the neighborhood of 95,000,000 tons or about 15,000,000 tons less than the estimated annual capacity (110,000,000 tons) that has been mentioned."

Electric Steel Furnaces

There has been a large increase in the number of new electric arc furnaces installed during the past year. One electrical manufacturer reports that it has accepted orders for transformers and control equipment for more than 60 electric arc steel melting furnaces. Of these furnaces, 22 were of 50 tons or greater capacity, indicative of the trend toward larger units. One company now operates 25 arc furnaces supplied from transformers totaling more than 260,000 kva. capacity.

Steel Employees and War Bonds

Voluntary payroll deductions among the men who are making the nation's steel is expanding. A December report of the American Iron and Steel Institute states that these wage-earning and salaried employees of steel companies are buying war bonds at the rate of $100,000,000 worth a year. Deductions for war bonds averaged $12.30 per man per month in September; an earlier survey showed an average of about $9 per man per month.

Wages per Ton of Steel Products

Late last year American steel companies were paying their employees about 13 per cent more in direct wages per ton of products turned out than they did a year previous. There was no change over the period in the prices at which iron and steel products were sold.

(Additional "Trends" on page 276)

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By Edwin F. Cone, Editor

Magnesium in Aircraft

During 1942 about 99.5 per cent of all the magnesium produced was going into aircraft, according to an authoritative article. "It now averages about 1,000 lbs. per plane in wheels, engine parts, gasoline tanks, cowlings and trim. It is already flying in other structural test parts, and may build up to several times the present poundage per plane."

Triplex Melting

The triplex process of producing steel or iron, particularly for castings, is gaining in favor — at least two large foundries in the Detroit area have installed it. Ford is using this triplex melting process — cupola, converter and electric furnace — in his new foundry where many steel castings for tanks are being produced. The Detroit Gray Iron Foundry Co. has 4 cupolas, 2 electric furnaces and 3 converters.

Malleable Castings

Output of malleable castings continues to rise but orders are declining. The October production last year was 64,719 net tons as compared with 56,687 tons in September and 56,304 tons in August. While the October output was well below the average for the 20 preceding months, it was the largest for any month since April when the total was 71,150 tons. Orders for the first 10 months of last year were about 10 per cent lower than for the corresponding period in 1941.

More Pig Iron from Less Furnaces

With only 11 blast furnaces operating out of 12, Gary Works of the Carnegie-Illinois Steel Corp. recently made more pig iron in one week than the 12 furnaces did in any previous week. The new record was 84,082 tons, exceeding by 245 tons the total from 12 stacks during a week last June.

Changes in Steel Melting Practice

More pig iron and less scrap is being used in the charges of open-hearth furnaces than in 1941. According to a study conducted by the American Iron and Steel Institute, an average of 557 tons of pig iron was consumed in 1941 per 1,000 tons of open-hearth steel. In the latter part of 1942 as much as 593 tons of pig iron was being used to make the same amount of steel. Over the same periods scrap consumption dropped from 523 to 496 tons per 1,000 tons of steel produced.—"By changing in that way, and also by using a slightly greater proportion of iron ore in the open-hearth charge, steel men have been able actually to produce more steel in 1942 than in 1941, despite the problem of scrap supply."

Pig Iron Data

After suppressing the publication of data on the output of pig iron for the country early last year, though permitting the issuing of steel ingot data, the Government late in the year removed its restrictions so that the pig iron data were available. These show that for the 10 mos. ended with October the total was 49,665,163 net tons as compared with 46,191,610 tons to Nov. 1, 1941. The October output of 5,236,608 tons was the largest on record. The output to Nov. 1 was 98.7 per cent of capacity. Part of this expansion is due to increased capacity — new and rebuilt stacks.

Steel Castings

The production of steel castings for the first 10 months of 1942 averaged 135,400 tons per month — a substantial increase over the 1941 and 1940 monthly rates which were 109,600 tons and 66,500 tons per month respectively. These data come from the Bureau of Census, Dept. of Commerce

Electrolytic Tin Plate

It is estimated that the production of electrolytic tin plate for 1942 was about 100,000 tons or about 4 per cent of the total. Probably by the end of 1943 not less than 60 per cent of the total produced will be the electrolytic product.

German and American Alloy Steels

Supplies in Germany of alloying materials for producing alloy steels are not increasing. According to a recent study of the American Iron and Steel Institute, Germany has available in Continental Europe only about one-third of the manganese, less than half of the chromium and a mere 10 per cent of the nickel needed to keep pace with the United States in making alloy steels. She must fall back on previously accumulated stockpiles which must have been heavily depleted.

More Steel Ingot Capacity

The steel expansion program of the WPB is reported as proceeding satisfactorily. The 10,000,000-ton increase in ingot capacity is expected to be completed by June, 1943, unless some unexpected delays are encountered.

(Additional "Trends" on page 274)